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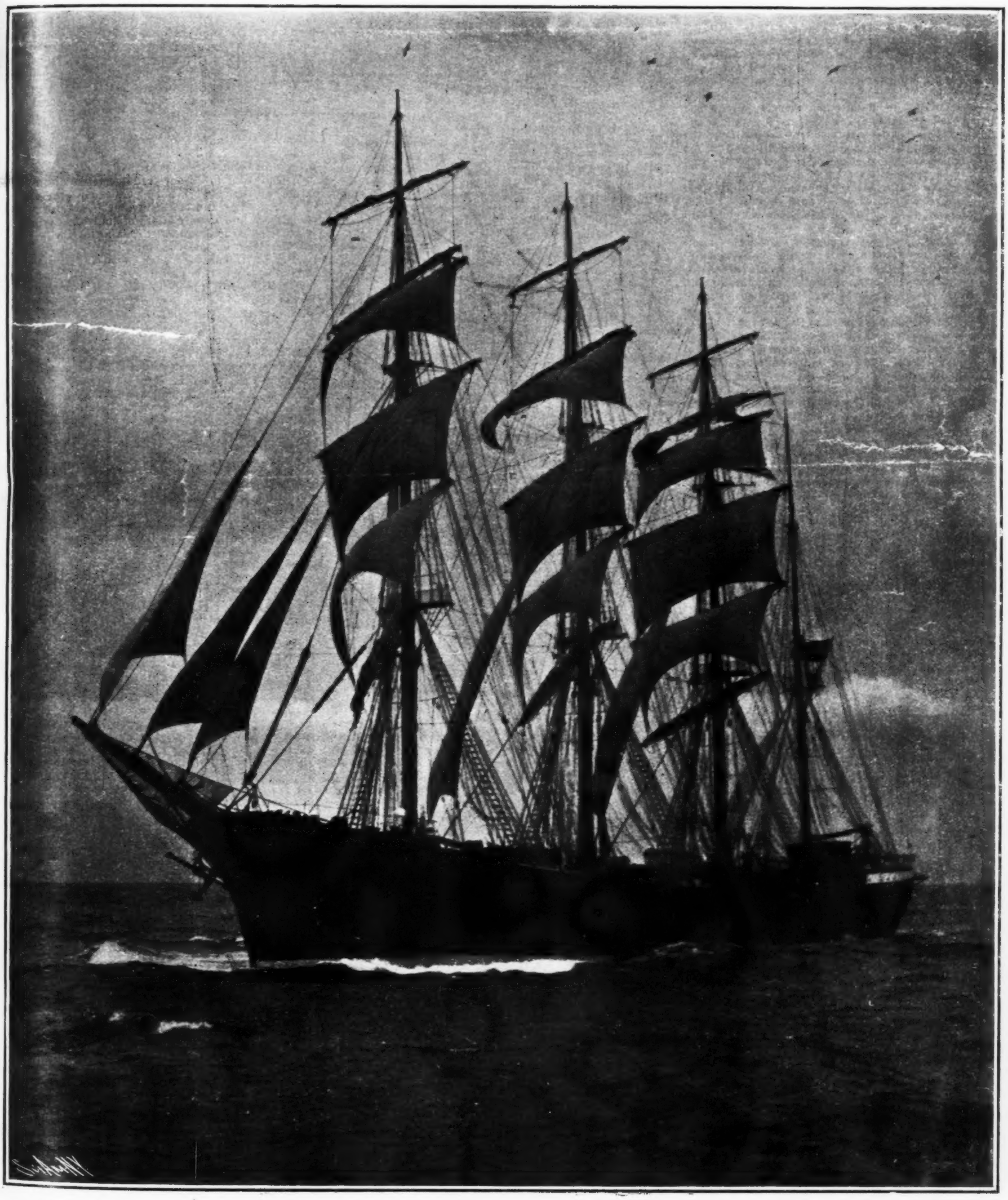


THE GERMAN SHIP "BARMBEK"—A SPEEDY SQUARE-RIGGER.

THE PASSING OF AMERICAN SQUARE-RIGGED VESSELS.

THE PASSING OF AMERICAN SQUARE-RIGGED VESSELS.*

By James G. McCurdy.

That the American square-rigged sailing vessel is being gradually forced from the ocean highways, where it was long an important factor in the world's carrying trade, has been apparent for some time to those well versed in maritime affairs. That the conditions which have brought about this result were likely to continue, thus rendering the future of this portion of our deep-sea merchant marine one of extreme uncertainty, was also quite well understood.

Yet few have realized that the outlook for vessels of this type is as serious as has been set forth by the Commissioner of Navigation in his last annual report, lately from the press.

Under the caption "Decline in American Square-rigged Shipping," the commissioner discusses the situation at some length, and places himself on record as of the opinion that the existence of our square-rigged fleet cannot under present conditions extend beyond the period of twenty years. The statistics submitted in support of this estimate seem logical and convincing.

On June 30, 1894, there were 633 square-rigged vessels flying the stars and stripes. By June 30, 1904, the number had diminished to 322, a decrease of 311, or 49+ per cent. This, too, in face of the fact that by the annexation of Hawaii, 18 fine square-riggers were added to our merchant marine.

A second consecutive year has passed without the building of even one square-rigged vessel in the United States, something never heard of before. As the commissioner tersely expresses it, "the construction of square-rigged vessels has probably not entirely ceased in the United States, but the future output will not equal the loss through wreck, abandonment, and cutting down into barges."

The history of the square-rigger is inseparably interwoven with that of our country, and those who are conversant with the career of this type of vessel, will view its retirement with feelings of genuine regret. Authorities all agree that it was the handsomest rig of vessel that has ever engaged in traffic upon the ocean. There was beauty in every curve of the famous clippers that sped across the deep, and long before the era of arrogant steam, they had carried our flag to every seaport of the globe, and had given us a standing among the nations of the world.

Sentimental reasons do not alone enter into the feelings of regret that the rapid disappearance of these vessels excites. Originally the craft "which drew the world together and spread the race apart," they developed a type of seamen such as the world had never seen, and which can never be duplicated under steam navigation.

Those competent to express an opinion, hold that there would be a serious national loss to safe navigation if the square-rigged fleet were allowed to die out as rapidly as it seems destined to do under prevailing conditions. The time will doubtless come when ship training will not be deemed essential to the successful navigation of an ocean steamer; but at the present moment many cling to the idea that those in command of steamships should have had preliminary schooling on a square-rigger. In other countries, notably Germany, large steamship corporations keep in reserve sailing vessels, where the future officers of their steam fleets can receive training.

It is quite the fashion at the present time to place the responsibility for the decadence of American sailing vessels entirely upon the foreign ships that have entered into competition with them; but this is only half a truth. It is a well-known fact that these foreign ships can be operated much more cheaply than ours. Then, too, some are helped by government bounties, as for instance the French vessels, which can sail around the world in ballast and still make a profit. Vessels of this character, placed in competition with ours, necessarily tend to depress freight rates, and likewise secure considerable business that would otherwise go to American vessels. But the fact remains that the foreign square-riggers are having almost as keen a struggle for existence as our own. When foreign shipowners allow fine large vessels to lie idle month after month in American ports, rather than attempt to run them at the ruinous rates that have prevailed for the past few years, it proves conclusively that the foreign owner of sail tonnage is not receiving much in the way of profits. Many foreign vessels, in the endeavor to keep in commission, have left Puget Sound ports with every cent of freight money drawn in advance and expended for loading and port charges, with the discharging expenses a dead loss to be borne at their journey's end. It was the foreign owners of sail tonnage that entered into an agreement not to accept charters below a certain figure, a movement that has had a tendency to improve rates, but to which American vessels have lent no assistance whatever.

Steam tonnage and vessels of the schooner type are largely accountable for the retirement of the square-rigger, whether it be American or foreign-built. The advantages of steam need no enumeration here. Schooners have many points of superiority over the square-rigger. They make quick passages, are good carriers, and can take on large deck-loads. They require but half as many men as a ship-rigged craft, as their sails can all be handled from the deck, and mostly with steam power.

Upon the Pacific coast the schooner is no longer merely a coaster, but has invaded the field formerly held by the square-rigger. We find them taking cargoes to China, Japan, Australia, South Africa, and even to Atlantic ports. As they can run so economically, they can make a profit on charters that would mean a dead loss to a ship.

As the schooner can do the work of a square-rigger, and do it at less expense, it stands to reason that those wishing to increase their sail property will build fore-and-afters instead of barks or ships. In like manner, later on, if conditions justify, they will build steamers in place of schooners.

The firm of Arthur Sewall, of Bath, Me., have endeavored for years to keep a fleet of square-riggers on the high seas, but now, after building ships since 1823, have announced that they will build no more. To-day, their fleet flag, which has been a familiar sight in all the great ports of the world for the last three-quarters of a century, is rapidly disappearing, even as their great shipbuilding plant is rusting to decay.

About sixteen years ago the Sewalls projected a fleet of fine ships, to bear the names of southern rivers. The "Rappahannock" was the first constructed, followed by the "Susquehanna," "Shenandoah," and "Roanoke," ranging in size from 2,700 to 3,500 gross tons. Misfortune followed in their wakes, and of these fine ships, only the "Shenandoah" remains. They made but little money for their owners, but demonstrated conclusively that under present conditions to build more vessels of their kind would be folly.

The practice of dismantling old ships and turning them into towing barges has been in vogue for some time, but converting stanch square-riggers into schooners is a somewhat new idea. Nevertheless, it has been done in several instances upon the Pacific coast with perfect success, and bids fair to become a general custom. Recently the "Snow and Burgess," an old State of Maine bark, was transformed into a five-masted schooner and has been beating all her previous records, besides cutting down her running expenses and increasing her carrying capacity. The old ship "Invincible," built in Bath in 1873, has also been converted into a schooner, and is again in commission after having been laid up for an indefinite period.

Of the 298 square-riggers in commission June 30, 1905, a large majority are in the hands of western owners, and are operating upon the Pacific coast. The lumber trade of the Pacific Northwest offered some inducements to these vessels, and some years ago a general exodus took place from the congested Atlantic ports to the Pacific, where ready employment was found as lumber carriers.

But now the time has come when even this trade is being rapidly absorbed by steamers and schooners, and to-day a number of these fine old vessels are loading cargo for Atlantic ports, to be dismantled upon arrival at their destinations, not many miles from where they entered upon their careers years ago. Dismantling, or conversion into schooners—such seems the fate of the remainder of the square-rigger fleet.

It is doubtful if any plan could be devised whereby the decadence of these vessels could be stayed. Any scheme of subsidy that could be enacted would apply to other forms of carriers as well, and would not tend to lessen the handicap under which ships are laboring. Nor does it seem probable that circumstances will so adjust themselves as to bring about a revival of this class of shipping.

The square-rigger has fulfilled its mission in the world's transportation system, and like the canoe of the trader on inland waters, or the ox-team of the pioneer upon land, it seems destined to pass into history as one of the utilities that was good enough in its generation, but must now be superseded by those more in keeping with modern requirements.

*Specially prepared for the Scientific American Supplement.

THE ETHICS OF TRADE SECRETS.*

By Frederick P. Fish.

The trade secret that interests us to-day as a practical and substantial feature of our industrial relations cannot be considered apart from the law which confines it and alone determines its extent and character as a thing capable of discussion. In so far as such a secret is protected, it may be regarded as a species of property. It is, however, obviously not tangible property, like lands or chattels. It is not even of the class represented by stocks, bonds, or other securities. Its legal recognition implies a right to a thing that is tangible, to an idea or plan. In this respect it may be compared not only with the property in inventions, in so far as the same are protected by letters-patent, but with the limited rights which an author has to his literary productions, and the artist, musician, or playwright to the creations of his imaginative effort. It is only at a comparatively high stage of development in a community that the law recognizes and deals with such intangible rights. Early jurisprudence is largely concerned with personal rights and with tangible property. It is during the last hundred years that the right to the intangible properties has for the most part been crystallized into such shape as to be capable of definite expression.

Letters-patent for inventions grow out of the exception in the statute of James I (1623-4), which declared monopolies, so long a source of revenue to the British kings, and of hardship to the subject, to be illegal except when granted for a limited term for a new manufacture; but the development of patents and of patent law as an essential part of the prevailing industrial scheme, did not really begin either in Great Britain or in this country until well in the nineteenth century.

The definite development of the law of copyright, both that which is based on statute and that which is independent of legislative enactment, is in like manner comparatively modern. The first trade secret case was decided less than one hundred years ago.

In all the classes of rights to which I have referred there is this in common: ideas or thoughts or plans or schemes which are of value to the one who rightfully possesses them, are secured to him to a greater or lesser extent by the law.

The trade secret as we know it, as defined and determined by our rules of law which alone give it body and character, is, therefore, a comparatively modern institution. But there was a long history of trade secrets prior to our common law recognition of them.

In all ages many trade secrets have been in the possession of individuals, but for a long period of time they also were a great asset of trading communities and frequently of guilds or associations. Every effort was made to preserve them for the few who had the benefit of them. Always and everywhere those who did not have the secrets sought to learn them. While not as a rule protected by systematic rules of law, kings and governments often intervened to aid their subjects to preserve the secrets they had, and to learn those which they did not know. It seems clear that the right to preserve a trade secret if one could, and to an equal degree the right to get the secret of another by any means not offensive to the moral sense, were always recognized.

A reference to these trade secrets of the olden time, which seem to have had for the most part no definite legal sanction, is only material as affording a basis upon which public sentiment, with the sanction of the law, has given to us our trade secret of to-day. The whole industrial world was permeated with the idea of trade secrets and of their value. As the trades became more and more matters of individual enterprise, it was but natural that, with this history behind them, the sentiment of the community regarded them as a substantial thing to be dealt with on the grounds of public policy. It has dealt with them, through the law, exactly as it has dealt with copyrights and trademarks, and I believe in a way that is quite in harmony with the general thought of the time.

When our law of trade secrets was first formulated less than a century ago, the industrial conditions were nearly as remote from those of the present day as they were from those of the Middle Ages. The trades had, however, come generally into the hands of individuals. We had started on a line of industrial organization and development which has been consistently followed to the present time. Almost the cardinal principle of this line of development has been the encouragement of the individual to risk and effort. It has been generally recognized that the gain to the community would be the greatest if every member of it was stimulated to do his utmost for himself.

There has never been a time when there were not some dissenters from this general view. And there have been times in which the natural and perhaps inevitable development of current industrial methods has been such as to bring about a revulsion of public sentiment, more or less sound, and more or less justifiable, but at any rate to be taken into consideration as definitely affecting the trend of development of industrial ideas and industrial conditions. But it does not seem possible to deny that the general sentiment has almost always been in favor of the encouragement of the individual in his selfish aspirations for personal prosperity.

I see nothing in the temper of our own times to indicate that this broad view of what is for the common good has been shaken. Few doubt that an individual should get a personal benefit from his personal skill and energy. We know that the entire community profits by the deserved success of any individual in it. We feel instinctively that, if the efforts of individuals are attacked or discouraged, all will suffer. The time may come when different views will prevail, but I do not anticipate that such will be the fact.

It is upon these fundamental principles that the underlying right to the protection of a trade secret, in so far as it is or can be protected, depends. The right is logical and will be asserted and enforced by public sentiment and by the law until we cease to believe that individual effort should be encouraged as the most effective stimulus to industrial improvement.

A trade secret is one method of manipulating or combining materials, or of controlling or directing the forces of nature, or of organizing machinery, or the details of a business, which is the result of original thought, which is of trade value to the person who has the thought, or the right to apply it, and which is kept by him a secret that he may get from it a personal advantage not to be directly shared by his competitors.

The secret, therefore, is the man's own, to keep or to disclose, to use or not to use, as he pleases. No public policy or law can force its disclosure or use. But the one who has it can be encouraged to disclose it or use it, one or both. The patent law offers a reward for the disclosure of secrets of a certain sort, and incidentally encourages their use. The law relating to trade secrets does not tend to promote the disclosure of them, but the contrary. It does encourage their use.

If such secret is of the slightest value, its use as distinguished from its suppression is obviously desirable. The possessor of the secret will get some benefit from its use; but the community as a whole is far better off if the secret is utilized.

It has never been suggested that the law should go so far as to protect a trade secret that was not a real secret. Such a proposition is entirely inconsistent with the common sense and intelligence of mankind. How-

* From an address delivered before the American Society of Mechanical Engineers at New York.

ever brilliant may be a thought or an idea, whether it is of value to the industries or to literature or art, when without dishonesty, fraud, or treachery, it has once become known, it is common property. But the law can say, to encourage the use of such a secret, that those who are bound by contract or by good faith to aid in keeping it shall be held to their obligation.

It is just to this extent and no further that trade secrets are protected. The law does not intervene to protect the secret against discovery by fair and honest means. It does not undertake to make the secret, as such, secure. It only enables it to be utilized, for the good of the possessor and of the public, without danger of betrayal by those who must necessarily learn the secret in confidence while it is being operated as a secret, and who can betray it only by what the law regards as a breach of honesty and fair dealing.

There may be others, not directly associated with the work, to whom the secret is imparted in confidence. Is it not proper that they should regard that confidence?

If the law and public sentiment were otherwise, no trade secret could ever be safely put into use. By holding to what seems to be only a fair standard of business ethics, those who gain a knowledge of the secret through a contract or a confidence that is reposed upon them, are prevented from disclosing it, and the desired result is accomplished.

It has been settled by an almost unbroken line of authorities, and it is absolutely clear at the present stage of the law, that a trade secret will be protected against disclosure by any one who has received it in confidence and under such circumstances that there is a contract, express or implied, that the person to whom the secret was disclosed should himself respect it. It follows that there is also a remedy against those who have received a disclosure of the secret from persons guilty of a breach of confidence or of contract in imparting it, unless they themselves were both entirely honest in the matter and protected by the equities of the situation. Against all others the owner has no redress. He can only invoke the power of the law to make effective an obligation to respect his confidence and to live up to an agreement.

For all practical purposes, the views of the courts are based upon a single and simple proposition. An individual is justly and honestly in possession of what is a real trade secret, that is, something useful in his business that is known to him and protected by him to the extent of his power as a secret of his trade. There seems no doubt that this is a real property interest exactly as an invention is property to such an extent that the government can make a contract with reference to it by which it is protected for a limited term by a patent, and exactly as an artistic or literary expression is protected as property. But in any event, it is obviously unfair that those who have entered into a fiduciary relationship with the possessor of the secret, or who by express contract or by a consideration of the relationship must necessarily be said to have assented to an implied contract to protect the secret, should undertake to rob the owner of his secret by communicating it to others or using it themselves. In a large number of the cases that have been before the courts, there has been no express agreement to protect the trade secret. There has been held to be, however, a necessary implication that such an agreement existed because of the relation of service.

But the courts have had no difficulty in the case of trade secrets. Recognizing the propriety of the proposition that they should be protected in cases where breach of confidence or breach of contract was involved, exact and well-defined principles with which the law was familiar, led to intervention by the courts, to see that that was done which was right.

While such cases ordinarily are brought in courts of equity, because, as a rule, an injunction is sought, an action at law may be brought for damages.

The injunction will run not only against the employee, but against those who, with knowledge of the confidential relations, have induced him to betray the secrets.

The vendee of the secret has the same right as the inventor of the secret and may bring a bill against the former employee of the vendor, who acquired the secret in confidence before the sale, provided the employee attempts to divulge the secret wrongfully.

Many trade secrets which are in their nature commercial, that is, business plans or devices, which were special to one who possessed them and useful in his trade, have been in like manner protected by the courts. Examples of these are shown in the following cases:

News agency contract, by which the plaintiff sent news to its subscribers under contract not to divulge it, is enforced in equity.

Contracts of commercial house must be kept secret by a clerk.

Forms and materials for printing advertisements in plaintiff's publication cannot be used by his agents for a rival publication.

Confidential attorney's clerk enjoined from publishing extracts from books and papers of his employers or of their clients.

Order books containing customers' names cannot be copied by an employe to use later in his own business for soliciting orders.

Perhaps as comprehensive a statement of the general law as any is that of Mr. Justice Story in 2 Story's Equity, Sec. 952, as follows:

"Courts of equity will restrain a party from making a disclosure of secrets communicated to him in the course of a confidential employment. And it matters not, in such cases, whether the secrets are secrets of trade or secrets of title, or any other secrets of the party important to his interests."

(To be continued.)

POWER REQUIRED FOR REFRIGERATION.*

By CHARLES L. HUBBARD.

REFRIGERATION is commonly produced mechanically by liquefying a gas like ammonia or sulphur dioxide under a high pressure, and then allowing it to vaporize at a lower pressure.

The process of vaporization absorbs heat the same as when steam is formed in a boiler, and this results in lowering the temperature of the medium surrounding the pipe or chamber in which vaporization takes place.

In the ammonia *compression* machine the gas is first compressed, then passed through cooling coils, called the condenser, where it is liquefied. From here it is slowly fed into a coil submerged in brine, one end of which is connected with the suction of the compressor. As the small stream of liquid ammonia flows into the coil, which is under a lower pressure, it vaporizes, and in so doing, absorbs a certain amount of heat from the surrounding brine, thus lowering its temperature. The brine is then circulated through coils arranged along the ceilings and walls of the rooms to be cooled. Sometimes the coils in which vaporization occurs are made to take the place of the brine coils, and the heat is abstracted directly from the air of the room without the use of brine.

In the *absorption machine*, so called, the results are obtained in a somewhat different manner, although the general principles involved are the same.

The capacity of a refrigerating plant is usually expressed in tons of refrigeration or "ice-melting effect." For example, a 10-ton machine will produce the same cooling effect in 24 hours as the melting of 10 tons of ice, or in other words, will extract the same amount of heat from the brine as would be required to melt 10 tons of ice into water at a temperature of 32 degrees.

The indicated horse-power required per ton of refrigeration depends upon the suction and condenser pressures, which in turn are governed by the temperature and amount of the condensing water used. Under ordinary conditions where condensing water must be obtained at average city prices, the most economical results are obtained with suction pressures ranging from 20 to 30 pounds, and condenser pressures of 140 to 150 pounds gage.

Under these conditions one indicated horse-power at the steam cylinder will produce about 60 pounds of ice-melting effect per hour, or three-quarters of a ton per 24 hours. This will, of course, vary somewhat with the range of pressure and also with the size and type of machine, but in the absence of more exact data, may be used for approximate results. Another method in common use is to provide 1.5 indicated horse-power per ton of refrigeration, which is slightly more than in the previous case.

If the compressor is operated by steam, the boiler power is determined in the same manner as for a steam engine of the same indicated horse-power. This varies a good deal even with the same type of machine, depending upon the size and speed, the pressure carried, and the point of cut-off.

The following table gives about the average steam consumption per hour per indicated horse-power for first-class engines of medium size:

	Pounds of Steam per I. H. P. per Hour.	
Type of Engine.	Non-condensing.	Condensing.
Simple high-speed....	30—34	22—26
Simple Corliss	26—30	20—24
Compound high-speed..	24—28	18—22
Compound Corliss	22—26	16—20
Triple exp. high-speed.	22—26	16—20
Triple exp. Corliss....	20—24	14—18

The higher figures may be used for engines from 75 to 200 horse-power, and the lower for sizes from 200 to 500 horse-power. For engines smaller than 75 horse-power they should be increased slightly.

Having determined the probable weight of steam required per hour for the particular type of engine, and knowing the temperature of the feed water and the boiler pressure to be carried, the weight of steam required can be reduced to an equivalent evaporation from and at 212 degrees, and this result divided by 34.5 will give the boiler horse-power required.

If the machine is motor driven, the required power must be increased from 20 to 25 per cent for losses in the generator and motor.

Example: What boiler horse-power will be required to operate a 50-ton refrigerating plant running 24 hours per day; the compressor being of the steam-driven type, with a simple non-condensing engine using 32 pounds of steam per indicated horse-power per hour?

Temperature of feed-water 60 degrees, boiler pressure 80 pounds.

$50 \div 0.75 = 66.6$ indicated horse-power of compressor. Calling it 70, the steam consumption will be $70 \times 32 = 2{,}240$ pounds per hour. The factor of evaporation for the conditions stated is 1.19, from which the boiler horse-power is found to be

$$\frac{2{,}240 \times 1.19}{34.5} = 77$$

If the machine was motor driven, the indicated horse-power to be provided by the engine driving the generator would become $70 \times 1.2 = 84$, and the steam consumption would be figured accordingly.

* Power.

A PERPETUAL CALENDAR.*

By CHARLES E. BENHAM.

THE practical utility of a simple method whereby, without pencil, paper, or reference table, one is enabled to tell almost in a moment the day of the week for any given date is so great that anyone who has been at the small pains necessary to master the process will never repent of having done so. On the contrary, he will only wonder that a formula so simple and so advantageous is not made a part of the regular curriculum of every elementary school.

At a first glance the system prescribed may seem a little complicated, but with very little practice it becomes perfectly easy and simple, while anyone with a natural talent for mental arithmetic may speedily acquire ability to perform the process with such rapidity that his powers seem, to the uninitiated, little short of magical.

The method depends primarily upon a system of casting out the sevens, that is, dividing by seven and taking only the remainder. Thus, 24, when the sevens are cast out yields 3; 21, 0; 40, 5; and so on.

Bearing this in mind, the process for a perpetual calendar is simply to add together four numbers, representing respectively century, year, month, and day of month, casting the sevens out as the addition proceeds. Thus, if those four numbers were 0, 23, 6, 14, we should add together 0, 2, 6, and 0 = 8, or, casting out the sevens, 1, which would mean that the date in question was on the first day of the week, or Sunday.

But what we have to arrive at is how to ascertain the four appropriate numbers for a given century, year, month, and day.

The rule is as follows:

(1) For the Century Numbers.—These must be memorized, 2 for the century 1800-99, 0 for 1900-99, and 6 for 2000-99. These are thus fixed for convenience, because the system being calculated on this basis, the 0 for the present century, which is most likely to be wanted, will save calculation. This arrangement is a modification, by Mr. Robert Cook, of Chelmsford, of Howard's Perpetual Calendar, in which the 0 was fixed for the previous century.

(2) For the Year.—Cast out the sevens from the last two figures of the year and add the quotient of the same figures, divided by four, neglecting fractions. Thus, for 1860, the number is 4 + 15 = 19, or casting out the sevens, 5. For 1906 it is 0, for 1840 it is 5 + 10, or, casting out the sevens, 1.

(3) For the Month Numbers.—These must be memorized as follows:

Jan.	Feb.	March	April	May	June
1	4	4	0	2	5
July	Aug.	Sept.	Oct.	Nov.	Dec.
0	3	6	1	4	6

For leap years, January is 0, February 3, the others being unaltered.

(4) For the Day Number.—This is simply the number of the day of the month, casting out the sevens if necessary. Thus, the 3d is 3, the 25th is 4, the 31st is 3, and the 28th is 0.

Examples of the application of these rules:

Given such a date as Arril 15, 1860.

The century numbe:	2
The year number is..	5
	7
Casting out the sevens..................	0
The month number is.........	0
The day number (casting out 7's).........	1
Total	1

The day is, therefore, Sunday.

January 13, 1904.

Century number	0
Year number	5
Month number (leap year)...............	0
Day number, 13 (casting out the sevens).	6
Total	11

Or casting out the sevens, 4.

The day is, therefore, Wednesday.

When the process is carried out mentally, it will be immediately seen in practice that the casting out the sevens as the addition proceeds, does not encumber, but simplifies the operation, as it reduces the addition to small numbers, and the calculation is soon performed with surprising rapidity.

With regard to leap year, it must be borne in mind that at the even centuries there is no leap year unless divisible by 400. Thus, 1900 is not leap year, nor 1800, but 2000 is.

In the iron and coal industries blast furnace and coke oven gases are available as a by-product and may be used for the generation of power. These gases were formerly wasted, either by inefficient methods of transformation or by blowing them into the air. They were, therefore, called waste gases and were marked in the columns of plant economics as having no commercial value whatsoever. It is now regarded as correct to appraise these gases at a rate, (1) corresponding to that of a certain weight of coal of thermal equivalence, (2) to the amount of steam that can be generated by a certain measure of both fuels, or (3) to that of some other standard depending on local conditions.

* Knowledge and Scientific News.

THE MAKING AND THE USING OF A WIRELESS TELEGRAPH TUNING DEVICE.—IV.*

By A. Frederick Collins.

One of the difficulties usually encountered by the amateur wireless telegraphist who has constructed or is using a syntonic apparatus is that of bringing the receiving circuits of the receptor into sharp resonance with the oscillation circuits of the transmitter.

The tuning device, or more appropriately the "syntonizer" here described and illustrated, is an instrument that any operator can easily make and, by following the suggestions offered, the resultant product will be found to be at once simple, cheap, and efficient, admirably fulfilling the requirements for which it is designed and permitting even a beginner to adjust the high potential and high frequency circuits of both stations to a predetermined wave length and so effect syntonization between them.

The tuning device is primarily a closed circuit having an inductance and capacity equal to the closed resonating circuit of the receiver, but unlike the Slaby ondometer and Fleming cymometer it is not intended to measure the lengths of the emitted and received waves but rather to provide an adjustable standard for producing them, and again, different from those very useful and ingenious instruments, it is connected directly to the closed circuit of the oscillator, instead of inductively with it.

The principle upon which it operates is that by setting sliding contacts, of which there are two, on a number on the scale the wave length in meters is indicated, and then the closed circuit of the transmitter can be tuned to the tuning device, and thus not only the length of the electric waves emitted can be predetermined, but if the lengths of the sending and receiving aerials are the same it is easy to put the aerial wire system in tune with the closed circuits as well as to know when syntony prevails between the sending circuits and the receiving circuits.

The closed circuit device is shown perspectively in Fig. 1 and diagrammatically in Fig. 2. By referring to the latter it will be observed to consist of three parts, namely, a variable inductance coil, an adjustable spark-gap and a small condenser, the first two in series, the last shunted around the spark-gap. The inductance coil is made by using tinned copper wire

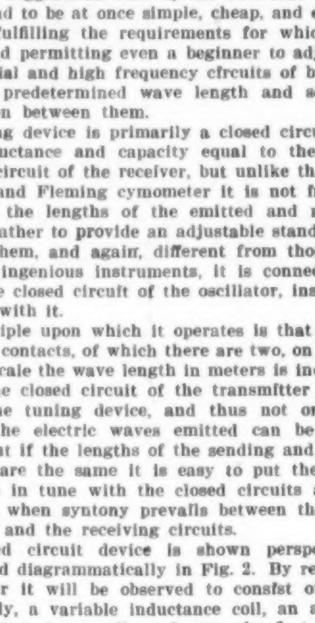


Fig. 1.—The Tuning Device Complete.

No. 16 B. W. G. and winding this on a light cylindrical wooden frame having a circumference of 90 centimeters. Each turn of wire represents a wave length of four meters, but since the turns are wound about 2 millimeters apart the actual length of each turn needs only to be 90 centimeters owing to the increased inductance due to the proximity of the turns of wire. There may be as many turns of wire as desired but the number should be the same as on the tuning coil of the receiver; at least 100 turns are essential so that the instruments may be tuned for any wave length up to 400 meters.

Mounted on top of the coil is a small spark-gap; this is formed of pointed wires, the opposite ends of which are connected to the tuning coil, one terminal leading to the upper end of the inductance coil and the other and opposite end to a flexible conductor to which is attached the lower sliding contact. The spark-gap terminals may be formed of two binding posts screwed to a hard rubber base and set about 4 centimeters apart and through the orifices of the posts darning needles or wires of any other metal having sharpened points are inserted; for the sake of convenience in adjusting it is well to have these fitted with handles.

The condenser shunted around the spark-gap should have as nearly the same capacity as the coherer used in the receptor; this condenser may be made of two sheets of tin-foil 2 x 3 inches separated by a thin sheet of glass or mica and protected on either side by similar sheets of glass, when it can be mounted on top of the frame of the inductance coil by the side of the needle point spark-gap. The photograph shows the inductance coil incased in a hard rubber covering but this is not at all essential to insure success but rather to give the device a finished aspect. It is well, however, to inclose the needle point spark-gap in a small case made of wood and having a glass front, since this will serve to exclude currents of air which might affect the spark length, yet at the same time permits the spark to be observed.

* Specially prepared for Scientific American Supplement. The article should be read in connection with the following articles by the same author: "The Design and Construction of a 100-Mile Wireless Telegraph Set" (Scientific American Supplement 1605); "The Location and Erection of a 100-Mile Wireless Telegraph Station" (Scientific American Supplement 1622); "The Installation and Adjustment of a 100-Mile Wireless Telegraph Set" (Scientific American Supplement 1623).

The scale may be of brass, hard rubber, or wood and a rule divided into millimeters will serve admirably. Brass is the most durable but if used care must be taken to insulate the contact points and connections from the slides. The scale may have 100 or more divisions, each division representing one turn of the inductance coil. Where the coil is left exposed spring clips may be used instead of the sliding contacts, or small metal wedges that can be forced between the successive turns of wire can be employed; such an arrangement is much easier to make but not quite as convenient to use.

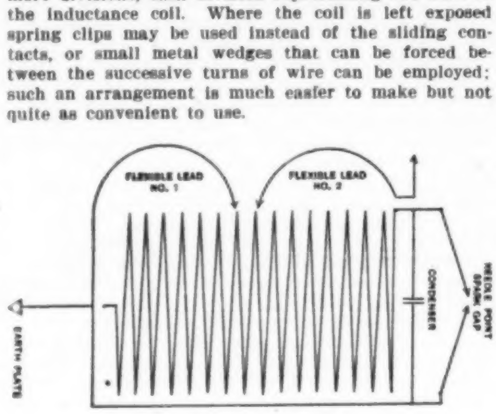


Fig. 2.—The Tuning Coil.

Having the device the next thing is to utilize it. Instead of trying to adjust the receiving station to the wave length of the sending station the process is reversed, since the closed circuit of the tuning device represents very closely the electrical dimensions of the resonating system of the receptor; in fact the tuning inductance coil of the receptor is exactly duplicated in the syntonizer, both electrically and physically. The difference in the two circuits is due to one having a coherer and the other a condenser and it is difficult to make these correspond in their capacity values.

Now an electric wave emitted by any plain open oscillating circuit is four times the length of the aerial so that if the aerial is 50 meters in length it will emit a wave 200 meters in length. Similarly a wave 200 meters in length will set up oscillations in a 50-meter receiving aerial that will surge naturally through it and hence the tuning coil of the closed circuit resonator which is coupled to the open-circuit aerial should be set on the fiftieth turn of the inductance coil which is a fourth of the wave length emitted, when the open and closed circuit of the receiver should now be in tune.

The contacts of the tuning device connected to the closed circuit of the transmitter are likewise set on the fiftieth turn of inductance coil since this is the same as the receiver is tuned for. The aerial wire of the transmitter is now disconnected from the closed oscillation circuit, and the spark-gap of the sending inductance coil is made very small, all of which is shown in the diagram Fig. 3.

When these preliminaries have been satisfactorily attended to the contacts of the large sending inductance coil 1 and 2 are brought together on the middle turn, the starting resistance of the primary circuit is thrown in and the key held down. The resistance is now gradually cut out until a bright spark is produced in the sending spark-gap; when this is obtained, the operator should open the needle-point spark-gap of the tuning device to about one centimeter and then the inductance of the sending tuning coil should be varied by moving the contacts 1 and 2 until sparking begins between the needle-points of the tuning device. When the sparking becomes brightest separate the spark-gap points a little farther and again adjust the positions of the contacts 1 and 2 and continue this process until the sparks have reached their greatest length and brilliancy, which shows that the sending closed circuit and closed circuit of the tuning device are in resonance, when the wave length of the former will be of course that of the latter and equal to the receiving station.

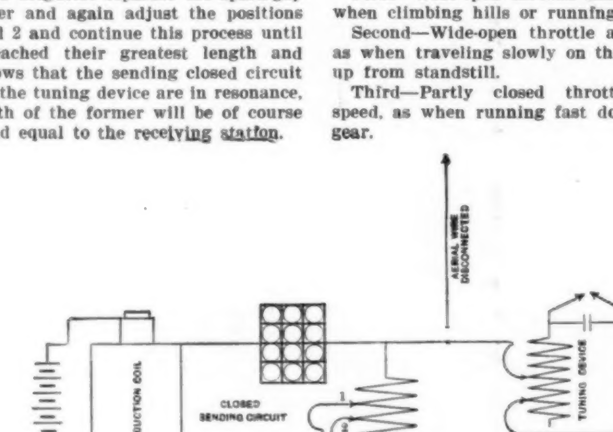


Fig. 3.—How the Tuning Device is Connected with the Closed Circuit of the Transmitter.

If the sending aerial wire is of a length exactly equivalent to that represented by the tuning device it will be very closely in tune with the closed circuit of the transmitter, but to tune the aerial wire to the closed oscillation circuit more accurately a hot wire ammeter must be resorted to, as described in Supplement 1623. Assuming the condenser of the tuning device to have the same capacity as that of the coherer, then the sending and receiving apparatus will be fairly well in resonance, i. e., syntonized. But the capacities of coherers vary considerably and hence the capacity of the condenser in the tuning device may be too great or too small.

There are two methods by which this difficulty may be obviated. The best and simplest is to insert in the closed circuit of the receptor a condenser having a capacity of say 1/10 of one microfarad, which is large compared with that of the average coherer. A condenser of like capacity may then be used in the tuning device when the capacity of the coherer may be ignored. Another means to ascertain if the sending and receiving circuits are in syntony is by actual testing, which as a matter of fact should be done anyway whether the condensers have a capacity approximating that of the coherer or whether these are large in comparison.

To make tests of this kind the stations must not be too far apart, that is, not over 25 miles at most. Then the sending operator transmits a letter—say the letter "S," represented by three dots—and keeps repeating this at intervals of several minutes, at the same time he reduces the amount of the initial energy. In the meantime the receiving operator keeps adjusting the inductance of his coil until the receiving circuits are in sharp resonance with the sending instruments, when the stations are ready for actual operation.

SOME REQUIREMENTS OF CARBURETER DESIGN.

In a paper read before the Society of Automobile Engineers, and reported in The Journal of Electricity, Mr. E. T. Birdsall, M.L., said that ever since the idea of using a vaporized or gasified liquid fuel in the internal combustion engine was suggested, the device for preparing the fuel for use in the engine has been a subject for much thought and study. Numberless designers more or less insufficiently armed with the proper experience, knowledge, and data for the task, have undertaken to solve the problem with varying results. As long as the principal requirement was to furnish fuel to engines working under a practically constant load and speed, and fuel was cheap, the defects of the early carbureters were not such as to interfere seriously with the operation of the engine. Other troubles, such, for example, as ignition, occupied so much of the operator's time, that the carbureter, so long as it worked at all, was neglected.

In the following remarks it is assumed that the engine used has a sufficient number of cylinders to produce a steady flow of mixture and that the carbureter is of the modern float-feed type, with a fuel jet and main and auxiliary air inlets. The fuel is assumed to be gasoline, although in the main alcohol or heavier oils require the same general conditions. The object to be attained is a mixture that will develop a maximum of power from a given size of motor with a minimum of fuel, not an average or "good enough" result.

With the use of the internal-combustion engine under extreme variations of load and speed, as demanded by the modern automobile, with the perfection of the ignition and other features, and with the rapid rise in price of the lighter oils, the subject of carbureter design becomes one of great interest and importance. Again, in a few years, when the commercial wagon will demand a low fuel cost combined with great certainty and flexibility of engine operation, the carbureter will probably determine the extent of the development of this, the most important branch of the automobile industry.

The function of a carbureter is to supply the proper mixture of air and fuel to the engine, under all conditions of speed and power. The four essential conditions under which carbureters must work are:

First—Wide-open throttle and high engine speed, as when climbing hills or running fast on the level.

Second—Wide-open throttle and slow engine speed, as when traveling slowly on the high gear or picking up from standstill.

Third—Partly closed throttle and high engine speed, as when running fast down grade or on a low gear.

Fourth—Nearly closed throttle and low engine speed, as with engine running idle when car is standing.

For some time it was thought that the best carbureter was one that gave a constant mixture under all conditions. But we now know that a constant mixture is not the best from either the standpoint of best operation or full economy. It was also thought that the best mixture contained just sufficient oxygen to entirely consume the carbon and hydrogen. It was found, however, that a mixture with a slight excess of fuel gave the best results. These facts being demon-

strated, it becomes almost obvious that the different engine speeds will demand different mixtures for maximum results. Thus at low speeds, the mixture should be richer than at high. This is due to the fact that at low speeds more heat is lost to the cylinder walls, more compression pressure is lost by leakage, and the combustion can therefore be slower, thus sustaining the pressure. At high speeds the compression is higher, due to less leakage and less loss of heat. Therefore unless the mixture was leaner at high speed there might be danger of pre-ignition. A lean and highly compressed charge also burns faster and hence gives better pressures and fuel economy than a richer one.

The quantity of mixture that an engine will take varies greatly with the speed. At slow speeds the quantity is equal to the cubic contents of the cylinders multiplied by the number of power strokes. At high speeds of 1,000 revolutions and over, the quantity may drop to less than one-half the theoretical amount, depending on the design of the valves, inlet piping, and carbureter passages. This peculiarity reacts upon the compression and hence on the mixture desired for best results. It will thus be seen that the design of the engine has a great deal to do with the carbureter design, which explains the well-known but seemingly mysterious fact that a carbureter that gives good results on one engine fails to maintain its reputation when applied to one of different design.

The design and class of ignition used have also a marked influence. Poorer mixtures can be used as the spark is hotter, the throttle can be more nearly closed, resulting in increasing engine capacity and fuel economy.

To get the maximum power out of a given sized engine the fuel should be introduced into the cylinders as cold as possible consistent with complete evaporation, intimacy of mixture, and completeness of combustion. To provide for the heat absorbed by the evaporation of the fuel, hot air is drawn in to form the mixture. The entire apparatus is heated by means of hot water or the general heat of the engine compartment under a closed bonnet is relied upon. The adjustment of this heat is an important matter but exact knowledge on the subject is apparently non-existent.

The ever-varying density and composition of the fuels used and obtainable introduce many and very serious complications into the problem. These differences demand different sizes of jets, different float levels, different amounts of heat to be supplied, and different proportions of air for combustion.

Different densities and temperatures of the fuel affect to a very appreciable extent the flow of the fuel from the jet. Between extremes this has been found to vary as much as 40 per cent. Thus a carbureter exposed to atmospheric temperatures in this latitude would seem to require a wide range of adjustment.

Owing to the absence of a ready means—like the pressure gage on the water circulation, or the voltmeter on the accumulators—of ascertaining the quality of the mixture being delivered by a carbureter, the majority of the motors in use are operating under more or less disadvantageous conditions, even if carefully and properly regulated at the outset.

The amount of reliable data and facts concerning the action of air and gasoline in a carbureter at the command of designers and students is remarkably small. Of no other part of the automobile is so little known. What is badly needed is a series of carefully planned and exhaustive experiments with data so arranged that it can be analyzed and deductions made.

THE DEVELOPMENT OF THE FRAME OF AMERICAN FREIGHT LOCOMOTIVES.

To the casual observer the frame of to-day would seem to be exactly like that of 25 years ago except in the matter of size. It consists of two bars, the upper one nearly square and the lower one of the same width as the upper, but narrower in vertical dimensions. These frames have always been made in two pieces, the back part containing the pedestals for carrying the axle boxes, and the front part rails to which the cylinders are fastened. It is the splice between these two pieces which has been the object of the study for improvement. In order to show how these details have been worked out step by step a series of illustrations are given showing the various changes in detail that have been made in the development of the fastening.

Fig. 1 is the type of fastening used in the late seventies. The frame was of wrought iron, and the front rail was joined to the main frame by a T foot whose upper arm was jumped on and held by countersunk bolts. In addition to the countersunk bolts through the pedestal, there were two vertical bolts holding the front rail to the drop of the main frame, and these bolts were supposed to be relieved of shear by the key that is shown between them. With the small cylinders in use at that time this frame gave little trouble, but with an increase in the diameter of the cylinders the repeated stresses would draw the countersunk bolts down and the nuts would come loose.

This form was followed by that shown in Fig. 2. But here the countersunk bolts joining the T foot to the main frame gave trouble by breaking, because the whole load would be carried by them in consequence of the springing of the two parts of the main frame. This construction was abandoned for that shown in Fig. 3, in which the lower portion was raised and made horizontal, with the front rail laid flat upon it and held by bolts, some of which went through the upper section of the frame, to which a key was added. This form gave excellent satisfaction, with cylinders up to 18 inches diameter. Heavier engines, however, required a stronger fastening, and a direct outgrowth of the form shown in Fig. 3 is that shown in Fig. 4, in which both upper and lower jaws of the main frame are horizontal, with the front rail between them and having a key on each side. This gave excellent service for a time, but again the increase in cylinder dimensions necessitated a change. The keys, which had but a half bearing in each of the two parts between which they were placed, would twist and throw the entire stress upon the bolts. To obviate this trouble the lower

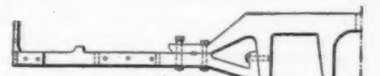


FIG. 1


FIG. 2


FIG. 3

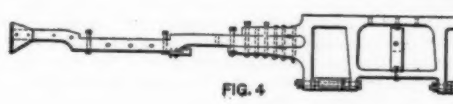


FIG. 4

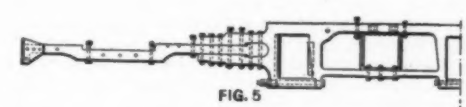


FIG. 5

frame was given a T head, as in Fig. 5, and keyed against the lips on the arms of the main frame.

Where double rails were used they were at first attached, as shown in Fig. 6, in which the lower rail had the same T head as in Fig. 1, while the upper rail was simply laid on and bolted to an extension of the upper frame. It was the standard method of construction for many years, and the only trouble experienced with it was an occasional breaking off of a T head. When this method of fastening became too weak for the increasing diameter of cylinders, the lower arm was made horizontal, but an upward bend of the front rail still left an opportunity to use the countersunk bolt through the pedestal leg, as shown in Fig. 7. This form soon yielded to that shown in Fig. 8, in which the T head was dispensed with and the front lower rail laid on like the upper one and bolted fast. This gave way to that shown in Fig. 9, in which the upper front rail was extended back over the jaw of the forward axle, while the upper arm of the main frame was run out to abut against the cylinder casting. The

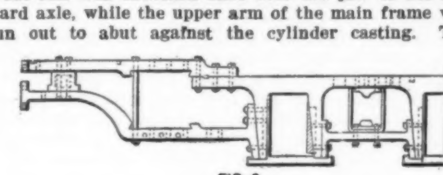


FIG. 6

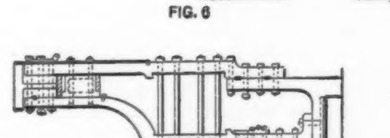


FIG. 7

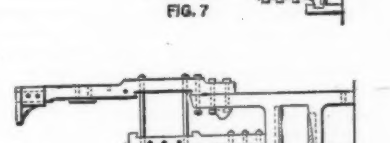


FIG. 8

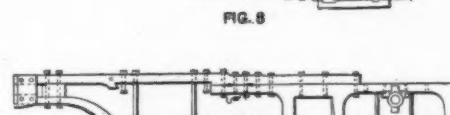


FIG. 9

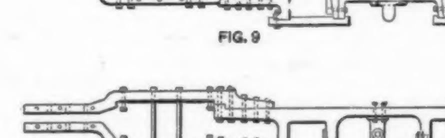


FIG. 10

lower arm was lipped up into the lower rail so as to form a bearing there for all back thrust of the cylinders. This in turn was followed by that shown in Fig. 10, in which the front upper rail was lipped down over the upper arm of the main frame, as in the case of the single rail frame of Fig. 5. Strong as this construction was, the stresses imposed by the cylinders were too great and, on the latest type of heavy engines, we find the form shown in Fig. 11 in use. Here the two front rails have been united in a single deep slab, to which the cylinders are bolted. These parts are no longer cast solid with a half saddle but are separate with a saddle between. The first frames of this sort that were built had the fastenings to the main frame as in Fig. 11, but they have been followed by that of Fig. 12, in which the upper rail has been carried back over the top of the jaws and keyed as shown.

During all this period of development there has been more or less activity in attempting to produce a cast-steel frame. First efforts were not altogether successful, but the desirability of securing such a frame, on account of the facility with which provision could be made for the attachments, together with the probable decrease in the cost of machining encouraged makers to persist in the work until now cast-steel frames like that shown in Fig. 13 are constructed, which can be made complete for less than the cost of finishing a frame of the older type. The result is that, though these frames are far from having come into general use, they may be considered to represent the latest type of the frame of the American locomotive.

The back part of the frame has changed but little in form. That of the early engines is shown in Fig. 14, and this still holds with such modifications as may be required to accommodate the trailing truck of the later classes of engines or to add to the depth of the firebox by the use of the drop in the upper rail, as shown in Fig. 15.

The examples given show the tremendous amount of tentative work that has been required in order to develop the locomotive to its present condition, and the end is not yet.—Railroad Gazette.

ALCOHOL ENGINES AS A FUTURE POWER.*

By ELIHU THOMSON.

THE internal combustion engine has undergone a great development in the past ten or fifteen years. Where formerly the Otto cycle or four-cycle type, as it is now called, with hit or miss governing was general, we now have variations in the method of governing of the four-cycle engines, and the modification known as the two-cycle engine, which has also received a considerable amount of attention. Formerly these engines, generally used with combustible gas, were constructed to be run at a steady speed with a more or less definite duty. In such cases the speed was maintained by a governor which was in many cases made to cut off the fuel charges abruptly so that the engine would fail to make an active or explosive stroke, or fail to make several explosion strokes at intervals, the active strokes coming in between and maintaining the speed of the engine at the normal, a heavy fly-wheel being a necessity of the case.

The Priestman oil engine, which began to be introduced some fifteen years ago, did not employ the hit or miss principle, but the charges were variably throttled by the governor so that each stroke was an active stroke; but the force of the explosion underwent great variation due to the differences of compression of the fuel charge and air. It is interesting to note that this method of operating engines is not only employed largely in gas engines to-day, but is also used in automobile engines using gasoline where the duty

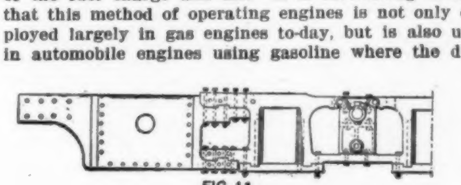


FIG. 11

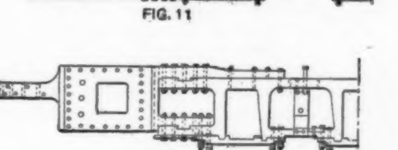


FIG. 12

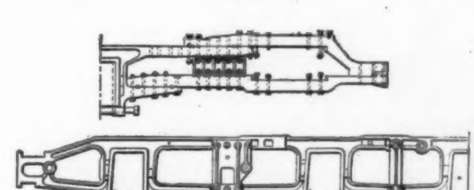


FIG. 13


FIG. 14

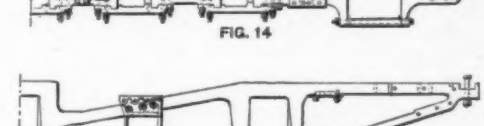


FIG. 15

is widely varied and where the speed is also subject to great variations. The Priestman oil engine employed the heavier oils, such as kerosene. The oil was put under a head of a few pounds and entered a heated vaporizer under control of a small conical valve actuated by the governor, which vaporizer was kept hot by the exhaust gases circulating around it. Through this same vaporizer the inflow of air took place and picked up the oil vapor which was drawn through an

* Electrical World.

automatic valve during the intake stroke. Thus the warmed air carrying vaporized oil entered the cylinder at atmospheric pressure when the engine was doing full duty, or at a less pressure when the engine was carrying only a partial load. The return or compression stroke of the piston brought the mixture of oil, vapor, and air to a pressure of some 20 pounds or more, and it was fired by electric ignition of the jump spark variety. The compression was necessarily low, as the charge having been preheated in the vaporizer would have been subject to the evil of pre-ignition had the compression been much increased. The economy of the engine was fair under full load, but under low loads the action was as if the fuel were burned to chase the piston.

In this case of burning under practically no compression the explosion stroke was not made efficiently. In the ordinary gasoline engine of to-day, such as is employed in automobile service, there is no definite speed governing, and the charge is introduced into the engine by suction of air, which carries with it gasoline spray and vapor. The vaporizer depends for its action on the suction of the intake stroke. In some forms of gas and oil engines the fuel charge is definitely fed by a fuel pump, and with the hit or miss type of governing the pump charge is definitely set to an amount which will just produce the proper combustible mixture with the volume of air taken in at each intake stroke. In other cases the effective stroke of the fuel supply pump has been varied with variations in amount of air indrawn, but this becomes a very difficult matter in the case where the engine is driven under considerable variations of speed. For this reason, the internal combustion engine, either of the four-cycle or two-cycle type, as employed in automobile and similar service, which may demand wide variations of speed and power, now generally employs a throttled intake and a vaporizer supplying the fuel charge to the air just before it enters the inlet valve or passage. In the two-cycle engine the mixture is generally made before it enters the crank case, from which it is expelled in the scavenging stroke to drive out the exhaust gases and take their place within the cylinder, ready for compression and explosion.

With gasoline as a fuel, which vaporizes at ordinary atmospheric temperatures, warming of the vaporizer or the entering air has been resorted to only in special cases, but the difficulty of obtaining grades of gasoline of the lowest boiling points together with the variation in effect when the outside temperature is low is tending to compel attention to the need of a warmed vaporizer. This is all the more so when engines of enlarged capacity are used. If the fuel in the vaporizer is of higher boiling point, the vaporization is then rendered effective by simply raising the temperature of the vaporizer, or raising the temperature of the fuel as it enters the air with which it is mixed; or while raising the temperature of the fuel also raising the temperature of the air somewhat so that it may the more easily take up and carry the vapor of the less volatile fuel.

In the case of denatured alcohol, which it is hoped may become available at a reasonable price before long, the same form of vaporizer as that used with gasoline will satisfy the conditions, except that it will receive a preliminary heating so as to confer upon the alcohol vapor the same degree of volatility as is possessed by gasoline at ordinary temperatures. In the same way, by raising the temperature of the vaporizer still more, it is quite possible to use liquid fuel of much higher boiling point, and even kerosene oil. The writer has, in fact, repeatedly run an engine with the vaporizer arranged to have its temperature controlled, and employed gasoline, alcohol, and kerosene oil interchangeably. An engine starting cold with an arrangement for allowing the exhaust gases to heat the vaporizer may burn a small amount of gasoline at the start, and on the attainment of a temperature sufficient to vaporize alcohol, the alcohol may be gradually turned into the vaporizer, and if the arrangement is such as to still further increase the temperature of the vaporizer, kerosene oil may finally replace the alcohol. But it is hoped that it will not be necessary to go so far.

It will doubtless take considerable time, possibly two, three, or more years, before the arrangement or organization for the production and distribution of the denatured spirit is sufficiently perfected to give us the product at a price which will compete with that of gasoline in the denser populated districts where the methods of distribution of the oil products are already in a high state of development. In the more sparsely populated districts, however, where, on account of the distances for distribution and inconvenience of storage gasoline now commands an advanced price, it should not be long before denatured spirit should be able to compete. It is fortunate that in spite of the considerably less heat value possessed by alcohol, as compared with any of the oil products such as gasoline, the efficiency of the engine may be increased in the case of the alcohol by increasing the compression so as to make up the difference. The limit of compression in the ordinary type of engine is naturally dependent upon the pre-ignition point of the charge during compression, and inasmuch as there is always a certain amount of the prior heated exhaust gas mixed with the new charge, while the cylinder walls are also necessarily at a considerably higher temperature than is the water in the jacketing, or than is the radiating metal where air cooling is employed, it is obvious that pre-ignition, when the heavier vapors are employed, must be regarded as setting the limit of compression which is feasible. Upon this degree of compression, however, the efficiency of the engine in large measure depends. With the employment of alcohol the compression may be so raised that two things are accomplished; first, there is a greater extraction of energy on expansion, resulting in a cooler exhaust; second, the cooler gas which remains in the cylinder and is mixed with the new charge results in further rendering pre-ignition improbable. It is true also that such a mixture would stand higher temperature of the walls of the combustion space without pre-igniting; consequently an alcohol engine can be run with the water boiling vigorously in its water jacket, a condition which almost invariably leads to pre-ignition difficulties with oil engines or gasoline engines unless the compression be kept quite low. It was noted in the Banki experiments that with oil engines the introduction of a certain amount of water in the form of steam or spray along with the fuel charge increased the efficiency of the engine. The commercial alcohol in any case will contain from 5 per cent to 10 per cent of water, and in the writer's experiments there was a tolerance of 15 per cent to 20 per cent; or in other words, about 80 per cent alcohol could be used. Below that point the ignition became somewhat irregular.

There is no need to dwell here upon the superior safety of alcohol owing to its higher boiling point and its condition of being perfectly miscible with water in all proportions. It is probable that the first development in the use of alcohol as a fuel for internal combustion engines will take place in farming districts or remote districts where gasoline itself is very high in price. It is also probable that at first the engines may be used with mixtures of alcohol and gasoline in varying percentages with a gradual increase in the percentage of alcohol as its price goes down and the price of gasoline rises. In this way a gradual adaptation of the conditions may take place and the present production of gasoline be spread over a fuel consumption of very much larger amount. The introduction of alcohol may, therefore, be said to practically make it possible to extend the use of gasoline. There is, of course, at present a field for the application of alcohol engines in such places as Cuba, which already possesses cheap alcohol fuel, these engines often being employed for driving dynamos for lighting or power transmission upon plantations or upon country estates, and it can confidently be expected that as soon as the conditions are such that the price of alcohol in the United States is brought down to a figure as low as that of gasoline in any section, a great opening for the use of alcohol engines will be made. It would certainly seem to be an ideal engine for use in agricultural districts for farm machinery and the like. It is quite probable that in districts where even water for cooling is scarce, air cooling may be resorted to with perfect success. At the same time alcohol would relieve boat propulsion by the internal combustion engine of a considerable proportion of its recognized dangers when gasoline or highly volatile hydrocarbons are used.

As a fuel for the operation of small or moderate capacity isolated plants, alcohol will undoubtedly find extended application. As such plants will run for a number of hours at least, after starting, the question of preliminary heating of the vaporizer will not constitute a disadvantage of any moment. The preheating can be accomplished in a minute or two without any risk by separately heating a mass of metal (as by an alcohol torch) and placing it in contact with the metal of the vaporizer itself, and the heated metal piece may be made to jacket or closely surround the vaporizer, with considerable surface in contact with the same and if needed its outer exposed surface be covered, permanently or temporarily, by a non-conductor of heat such as asbestos. Electric ignition of the make-and-break type or of the usual jump spark type may, as with gasoline, be applied. There would be no possibility of interruption due to freezing, as is the case when gasoline carries a little water, which later congeals in the passages. Moreover, since the alcohol engine can be used with the jacket water at boiling temperatures, the heat of the jacket, supplemented as it can be by the exhaust gases applied to further heat or to boil water or vapor, may be used in winter for steam heating or hot water heating either alone or in conjunction with existing plants for that purpose. There is no need to dwell upon these possibilities, all so conducive to economy of application of the fuel.

In the foregoing attention has been briefly called to the peculiar fitness of alcohol for power purposes, the properties of which, together with the conditions of use, are alike favorable to its employment. It has sometimes been objected that the products of its partial combustion or oxidation are likely to be acid and corrosive for such a metal as iron. If experience should show any considerable disadvantage in this, such corrosive action would only take place with the engines out of action or resting between runs and doubtless could be neutralized by suitable means such as oil or alkaline substances introduced at the time of a shut-down lasting for a period more or less prolonged. Doubtless also a proper selection of materials for valves or valve seats subject to corrosive action would eliminate all difficulty arising, if any exist.

A PECULIAR BISMUTH-TIN-LEAD ALLOY.

The alloys of lead, tin, and bismuth show peculiar properties. A mixture consisting of the following:

Bismuth	2 parts
Tin	1 part
Lead	1 part

melts at a temperature slightly below the boiling point of water. It also expands on cooling so that it is quite suited for taking delicate impressions of dies, etc. For this purpose it may be used in the plastic condition and pressed into the mold. Upon cooling, it expands.

The most peculiar property, however, is the fact that it will become hot enough to burn the fingers after it has been cooled in water. This phenomenon is caused by the latent heat. The crystallization of the metal after it has been cooled causes the expulsion of the latent heat with this peculiar effect.—Brass World.

VIBRATION OF PASSENGER CARS.

The secondary movements set up in railway cars are complex and rather difficult of analysis, but they are worthy of careful study. The oscillations may sometimes be so great as to produce derailment, and the smaller but more frequent movements, which may be better termed vibrations, are frequently so decided and disagreeable as to result in considerable discomfort to the passengers. The subject has received little attention in a scientific way in the United States and there is here an opportunity for an investigation which would improve the spring arrangements of passenger cars and add greatly to the comfort of travel.

In France a number of delicate and precise instruments have been devised for measuring and recording the vibrations of railway cars. Some of these are arranged to transmit the records electrically, while others are operated by compressed air. On the Western Railways of France, the chief engineer, M. Sabouret, utilized the pneumatic system of transmission, which was devised by Marie, and made a study of car vibrations in detail, as these instruments enabled him to measure the irregular movement between parts not rigidly connected, such as those taken by an axle in relation to the truck, the movements of equalizing beams and buffers, as well as the transverse or vertical shocks produced by the unevenness of the roadbed. The Marie system of transmission is not adapted to very rapid movements, as the inertia of the air and of parts of the apparatus decrease its reliability and sensitiveness. Most of the secondary movements, however, have a duration not shorter than one-fifth of a second, and at this frequency the system is satisfactory. The results of Marie's comprehensive investigation were published in the Comptes Rendus de l'Academie des Sciences in 1905. The Sabouret instrument for registering the vibration of cars was illustrated in The Railway Age of December 29, 1905, page 829.

For similar investigations the Pennsylvania Railroad has recently imported for its testing laboratory a Milne vibrator, a beautiful instrument made by Munro of London. In this device the pendulums and recorder are arranged compactly on one base plate so that the whole instrument occupies a space of less than one cubic foot. There are three suspended brass weights arranged with bell cranks so as to transmit the vertical, horizontal, or longitudinal vibratory movements of a car.

The seismometers, which have been devised for measuring the direction, duration, and force of earthquakes and like concussions are not suitable for work on railway trains because they are over sensitive and neither compact nor portable. Their design is based on the inertia principle. A mass is suspended with freedom to move in the direction of that component of the earth's motion which is to be measured. When an impulse occurs the supports move, but the mass is prevented by inertia from accompanying them. It supplies a steady point to be used as a standard of reference in determining the extent through which the ground has moved, and the whole movement is resolved in rectilinear components which are separately recorded.

A modification of the seismometer was recently used by Mr. F. W. Huels in measuring the vibrations of cars produced by electric lighting engines, and the results of his experiment were given in a paper presented to the Western Society of Engineers December 19, 1906. The results of these experiments showed that the turbine engine produced by far the least vibrations, as might have been expected, but a more interesting fact brought out by the investigation is that the waves of vibration are transmitted back into the train as far as the fourth or fifth car through the buffers and vestibule plates. It is found that when the train comes to a stop with the buffers and vestibule plates tight together, much of the vibration from the electric lighting engine is felt in the train, but when the buffer plates are slightly separated less vibration can be detected.

A much larger disturbance of this kind is produced by the reciprocating parts of locomotives, which in the two-cylinder types are not fully balanced and produce longitudinal vibrations which are distinctly felt throughout the train. The influence of the buffer and vestibule springs in transmitting these vibrations is quite marked. These springs are usually too strong and the vestibule plates are pressed together with a considerable force when the draft springs are almost fully compressed. With this spring tension extending throughout the train, there is set up a periodic vibration which synchronizes with that of the counterbalance on the locomotive, and under these conditions the disturbing influence is at a maximum and the unpleasant motion is felt by the passengers. A similar effect is produced by the joints of the rails, which set up a periodic vibration of the bolster and equalizer springs. The disturbance caused by slight defects in track is overcome to a large extent in Pullman cars on account of use of six-wheel trucks which spread over a long wheel base and on account of the great weight of the car bodies which absorb whatever slight vertical vibrations may be transmitted to them. The introduction

of the vestibule, however, with very stiff buffer springs has no doubt aggravated the disturbance caused by the irregular counterbalance of the locomotive. With the introduction of steel cars making a more rigid structure, this evil will be still further increased unless some careful attention is given to the strength and adjustment of the buffer springs. Car wheels which are not truly circular, or which have flat spots on the tread, are also the frequent cause of unpleasant vibrations in cars, and these can be prevented by the use of the improved emery wheel grinders which have recently been perfected.—The Railway Age.

SELECTING THE PROPORTIONS FOR CONCRETE.*

By William B. Fuller.

The growing use of concrete for structures in which great care must be taken to have only the best material and workmanship, has stimulated investigations into the effect of varying the relative proportions of sand and stone in the mix, the proportion of cement to the total remaining the same, and the result has demonstrated very conclusively that the proper grading and relative proportion of the ingredients has a great influence on the quality of the concrete produced. To demonstrate this great effect, the writer made up a set of beams 6 inches square and 6 feet long, varying these relations very widely from almost all stone to almost all sand, and broke the beams after 30 days with results given in the table below. It will be seen that although the amount of cement in each of the beams was the same (namely, 1 to 9 of the total material), some of the beams were over 700 per cent stronger than others.

Proportions.	Modulus of rupture, lbs. per sq. in.	Proportions.	Modulus of rupture, lbs. per sq. in.
1 : 2 : 6......	319	1 : 5 : 3......	151
1 : 3 : 5......	285	1 : 6 : 2......	102
1 : 4 : 4......	209	1 : 8 : 0......	41

In investigating this subject over a term of years, it has been found that there is one combination of any given sand and stone which with a given percentage of cement makes the strongest concrete and this is the proportion which also gives the densest concrete, that is, the concrete which contains the least percentage of voids; or otherwise, that which weighs most per cubic foot. It is found also that this dense concrete is least permeable to water and consequently is the most durable, and it is also found that as a practical advantage such concrete is most easy to place, working easily and filling up all voids and bad corners.

The above stated law that the densest concrete is also the strongest gives a very easy way of proportioning the materials at hand so as to obtain the best and strongest concrete possible with these given materials. That is, to obtain these proportions by trial, as follows:

Procure a piece of 8 to 12-inch steel pipe about a foot long, and close one end; also obtain an accurate weighing scale. Weigh out any proportions selected at random, of cement, sand, and stone, and of such quantity as will fill the pipe about three-quarters full; mix thoroughly with water on an impervious platform, such as a sheet of iron. Then, standing the pipe on end, put all the concrete in the pipe, tamping it thoroughly, and when all is in, measure and record the depth of the concrete in the pipe. Throw this concrete away, clean the pipe and tools and make up another batch with the total weight of cement, sand, and stone the same as before, but with the proportions of the sand to the stone slightly different. Mix and place as before and measure and record the depth in the pipe, and if the depth in the pipe is less and the concrete still looks nice and works well, this is a better mixture than the first. Continue trying in this way until the proportion has been found which will give the least depth in the pipe. This simply shows that the same amount of material is being compacted into a smaller space and that consequently the concrete is more dense. Of course, exactly similar materials must be used as are to be used on the work, and after having in this way decided on the proportions to be used on the work it is desirable to make such trials several times while the work is in progress, to be sure there is no great change in materials, or, if there is any change, to determine the corresponding change in the proportions.

The above described method of obtaining proportions does not take very much time, is not difficult, and a little trouble taken in this way will often be productive of very important results over the guess method of deciding proportions so universally prevalent. I have repeatedly known concrete to be increased in strength fully 100 per cent by simply changing the proportions of sand to stone as indicated by the above method and not changing the amount of cement used in the least.

A person interested in this method of proportioning will find on trial that other sands and stones available in the vicinity will give other depths in the pipe, and it is probable that by looking around and obtaining the best available materials the strength of the concrete obtainable will be very materially increased.

As a guide to obtaining the best concrete, the proportion of cement remaining the same, the following are given as the results of extensive tests:

(1) The stone should all be of one size or should be evenly graded from fine to coarse, as an excessive amount of the fine or middle sizes is very harmful to strength.

(2) All of the fine material smaller in diameter than one-tenth of the diameter of the largest stone should be screened out from the stone.

(3) The diameter of the largest grains of sand should not exceed one-tenth of the diameter of the largest stone.

(4) The coarser the stone used the coarser the sand must be, and the stronger, more dense and watertight the properly proportioned work becomes.

(5) When small stones only are used, the sand must be fine and a larger proportion of cement must be used to obtain equal strength.

* Abstract of a paper read at the annual convention of the National Association of Cement Users at Chicago.

THE TREATMENT OF CONCRETE SURFACES.*

By Linn White.

A pleasing and consistent surface finish generally has but little to do with the strength of a concrete structure, but it is not inconsistent with maximum strength in any structure. Next to form or design the character of the surface has most effect on the appearance of concrete whether in a building, arch, wall, or abutment. In fact, when the view is had at a very close range, or in such structures as retaining walls or pavements the surface finish may take precedence over proportion. It is not intended to attempt a full discussion of the subject, but only to describe some methods used in trying to obtain satisfactory surfaces in the various classes of concrete work done in the South Park System of Chicago.

The imperfections in the exposed surface of concrete are due mainly to a few well-known causes which may be summed up as follows: 1. Imperfectly made forms. 2. Badly mixed concrete. 3. Carelessly placed concrete. 4. Efflorescence and discoloration of the surface after the forms are removed.

Forms with a perfectly smooth and even surface are difficult and expensive to secure. Made of wood as they usually are, it is not practical to secure boards of exact thickness, joints cannot be made perfectly close, the omission of a nail here and there allows warping, and the result is an unsightly blemish where least wanted. Badly mixed concrete gives us irregularly colored, pitted, and honeycombed surfaces, with here a patch of smooth mortar and there a patch of broken stone exposed without sufficient mortar. Careless handling and placing will produce the same defects.

But granting we have the best of labor, that all reasonable expense and care is had in making up forms, in mixing, handling, and placing the concrete; that it is well spaded, grouted, or the forms plastered on the surface, the results are not satisfactory. All these efforts tend to produce a smoothly mortared surface, and the smoother the surface, the more glaring become minor defects. The finer lines of closely made joints in the forms become prominent, the grain of the wood itself is reproduced in the mortar surface, hair cracks are liable to form, and (worst of all) efflorescence and discoloration are pretty sure to appear. We surely have been working on a wrong theory. It is of doubtful efficiency to line the forms with sheet metal or oilcloth. Imperfections still appear.

Two methods suggest themselves as likely to overcome the defects alluded to above ; (1) treating the surface in some manner after the forms are removed to correct the defects, and (2) using for surface finish a mixture which will not take the imprint of and which will minimize rather than exaggerate every imperfection in the forms and which will not effloresce.

Methods of treating the surface by bush hammering, tooling and scrubbing with wire brushes and water have been described, all of which have for their object the removal of the outer skin of mortar in which the various imperfections exist; but the method most used in the South Park work is the acid treatment. It consists of washing the surface with an acid preparation to remove the cement and expose the particles of sand and stone, then with an alkaline solution to remove all free acid, and finally giving it a thorough cleansing with water. The operation is simple and always effective. It can be done at any time after the forms are removed—immediately, or within a month or more. It requires no skilled labor, only judgment as to how far the acid or etching process should be carried. It has been applied with equal success to troweled surfaces, like pavements, to molded forms such as steps, balusters, coping, flower vases, etc., and to concrete placed in forms in the usual way. It, of course, means that in the concrete facing only such material shall be used as will be affected by acid, such as sand or crushed granite. It excludes limestone.

The treated surface can be made any desirable color by selection of colored aggregates or by the addition of mineral pigments. The colors obtained by selection of colored stone are perhaps the more agreeable and doubtless more durable. There have been molded in the South Park shops blocks for buildings, columns, architectural moldings, and ornaments, with both red and black crushed granite surfaces, also pavements laid in patterns with red and black granite, all treated with the acid to bring out the natural colors of the stone. There has been a large quantity of concrete pavement laid with torpedo sand surface colored a buff sandstone color with a small quantity of yellow ochre and mineral red and treated with the acid. The buff color imparted to the surface is a welcome relief from the glare of the ordinary whitish gray concrete pavement in the sunshine, and the etching of the surface adds to the softness of the color, at the same time preventing any slipperiness. This same buff color has been used to a large extent in steps, bases of lamp posts, and other molded articles to be placed on or near the ground. With white sand as the aggregate, thousands of pieces have been molded for coping, balustrades, concrete seats, drinking fountains, pedestals, etc., which when treated with the acid appear like a fine grained almost white sandstone.

* Abstract of a paper read at the annual convention of the National Association of Cement Users at Chicago.

Where there are projections or marks left by the molds or forms they are tooled or rubbed down before treatment, and where it is necessary to plaster up rough places or cavities in the surface, it may be done and after treatment cannot be detected. These various classes of work have been done on a large scale during the last three years in connection with the improvement of new parks and have in all cases proved satisfactory.

The second method referred to for preventing or minimizing surface defects has also been tried in the South Park work with quite a measure of success. During the years 1904, 1905, and 1906, groups of concrete buildings have been erected in nine different parks, costing with their accessories from $65,000 to $150,000 for each group. These buildings are all monolithic structures with occasional expansion joints, the exposed surfaces of walls being of a concrete composed of 1 part of cement, 3 parts of fine limestone screenings, and 3 parts of crushed limestone known as the ¼-inch size. This was thoroughly mixed quite dry, so no mortar would flush to the surface and well rammed in wooden forms made in the usual manner. The result was an evenly grained, finely honeycombed surface, of a pleasing soft gray color, which grows darker with time and blends admirably with the park landscape. In placing, it was not spaded next the form, it was too dry to cause any flushing of mortar, so there is no smooth mortar surface, the imprint of joints between the boards is hardly noticed, and the grain of the wood not seen at all. There is no efflorescence apparent on the surface anywhere, and cannot be on account of the dryness of the mix and the porosity of the surface. The buildings are used as gymnasiums, assembly halls, reading and refreshment rooms, and as a rule the same gray concrete finish is given the interior walls as the exterior. In some cases a little color has been applied on the interior walls and the walls of shower and bath rooms have been waterproofed with plaster. The porosity of the surface makes it well adapted to receive and hold plaster.

This sort of surface is not capable of treatment with acid as a smoothly mortared surface, nor is it desirable. Consequently the only color obtainable is the natural color of the cement covered stone, but which is softer and far more agreeable than the gray of the usual mortar finished surface. It is not suited for the surface of a pavement and is not impervious to water. Although it is evident that water enters the pores to a considerable extent, there is no evidence of injury from frost during the two winters some of these walls have stood. The same finish has been used for retaining walls, arch bridges, fence posts, walls inclosing service yards, etc. In the buildings, the thin walls were made entirely of this mixture while in the heavier structures it has been used only as a facing. Two reinforced arches of 60 feet span were faced with this mixture, but the steel was imbedded in a wetter, more impervious concrete. This same dry mixture can be used for molded stones when the mold is open enough to permit tamping, and of course it is eminently suited to block machines.

The dry, rich mix with finely crushed stone has been found specially suited to another condition where a sound, smooth surface was particularly difficult to secure, viz., for the under-water portion of a sea wall on Lake Michigan. It was mixed very dry and dumped in mass in sunken boxes joined end to end, made fairly water-tight, but from which the water was not excluded. With the finely crushed stone a sound, smooth surface was obtained (when the sides of the boxes were removed) where it was manifestly impossible to plaster or grout the surface and where spading a mix of coarser stone simply washed the cement away from the surface stones. On account of the variable water level it was particularly desired to have a sound, smooth surface.

Of the work described, most of the monolithic buildings, the arch bridges and some of the walls and paving have been done by contract. All of the molded work, the buildings made of blocks, service yard walls, etc., and all the acid treatment have been done by the park forces. Nearly all the various brands of Portland cement sold in the Chicago market have been used in varying quantities with equally good results.

In both methods described, honest work and careful inspection are as necessary for good results as in any other first-class construction. Neither method cheapens concrete work. The acid treatment slightly increases it. The surfacing with fine crushed stone adds nothing to the cost. By the acid treatment, together with rubbing and chipping, all irregularities can be corrected. With the fine crushed stone surface all irregularities and form marks are not prevented, but they are greatly minimized.

In not all the work done by the second method were the results entirely satisfactory. The original specifications called for ½-inch stone, which was afterward changed to ¼-inch. Experience taught the correct quantity of water to use for best results. But altogether both methods are so satisfactory that their use will doubtless be continued in the South Park work until something better is developed.

The manufacture of tantalum, one of the hardest metals known, into sheets and bars is now, it is said, being practised in Germany by the squirting process, the material in its original powdered form being mixed with water and gum tragacanth, and then successfully forced into rods and shapes as desired.

THE CAPE TO CAIRO RAILWAY.*

By the Hon. Sir Lewis Michell.

The exceptional man who achieves great things, generally combines the power of dreaming with the practical instincts necessary to enable him to translate his dreams into performances. And of such was Mr. Rhodes. The Cape to Cairo Railway is no unsubstantial dream but a reality, in advance of its age if you like, but still a reality, and already, in great part, an accomplished fact.

After several initial difficulties, the wires have been erected for no less than 1,584 miles. Leaving the Mashonaland Railway at Umtali, it follows the eastern boundary of South Rhodesia, traverses Portuguese East Africa, crossing the Zambesi low down at Tete, serving the well-known missionary station of the Scotch Church at Blantyre, and running through the coffee-growing districts of the Shiré Highlands to Fort Johnston—so named after Sir Harry Johnston—and then onward through the entire length of the British Central Africa Protectorate, touching at many rising villages on the shores of Lake Nyasa as far as Karonga, then westward to Fife and Abercorn, the latter the most northerly point in Northeast Rhodesia, and called, of course, after the present Duke, and a loyal and steady supporter of Mr. Rhodes and all his great plans for the civilization of a continent. From Abercorn the line enters foreign territory, and winding in and out close alongside the eastern shore of Lake Tanganyika, terminates at Ujiji, that historic spot where Stanley found the long-lost Livingstone—a spot which, I say it with regret, though ours by right of discovery, is no longer within our own sphere of influence. Further than this the wire cannot go, except on onerous terms and by permission of Germany; but even in its unfinished state it serves many public and private interests, assists in the preservation of law and order, and is of great and growing commercial value.

It is not so many years ago in point of time that Livingstone and Möhr, Speke and Grant, Baines and, above all, Stanley, roused public interest in the problems and populations of Central Africa. Their journeys were mainly east and west. But what Mr. Kipling well calls the immense and brooding spirit of Mr. Rhodes saw, as in a vision, that civilization and the trade that follows in its train, might with perhaps greater advantage be introduced into the heart of the Dark Continent from south to north. And instead of resting content with the transient passage of the adventurous explorer and mighty hunter who traversed the pathless forests and unfrequented solitudes of Africa, hatchet and rifle in hand, but left no permanent trace of their footsteps behind them, Mr. Rhodes conceived the nobler but the more practical dream of penetrating the ancient and mysterious continent once and for ever, by laying down from the shores of Table Bay to the blue waters of the Mediterranean, that twin steel rail which has done for the modern world what the great Roman roads did for Europe nearly 2,000 years ago. At what date the idea first occurred to him may, perhaps, never be known, for he was a silent man, not addicted to correspondence, and accustomed to much deep thinking before taking decisive action. But the following dates are significant and instructive.

It was the Conference of Berlin, early in 1885, which drew public attention to Central Africa, by stipulating for freedom of trade and the suppression of the slave traffic in the basin of the Congo. In the same year the Cape government railways, thanks to Mr. Rhodes's persistence, reached Kimberley. In the summer of 1888, he suggested, through a now extinct company—the Exploring Company—a prolongation of the line to the then remote and inglorious village of Mafeking. In the same year he persuaded the home government, after persistent pressure, to declare Matabeleland and Mashonaland a sphere of influence. Great Britain, then as now always unready, was only just in time. Prince Bismarck and President Kruger were neither of them asleep, and but for the masterful energy and driving power of Mr. Rhodes, the entire territory now known as Southern Rhodesia would have passed into foreign and unfriendly hands, and our access to the vast interior would have been barred for ever. In the following year, 1889, Mr. Rhodes having acquired by concession, purchase, or otherwise all the land and mineral rights between the Limpopo and the Zambesi, absorbed the exploring company and other similar expeditionary and prospecting ventures, and at once applied for a royal charter to enable him, under the authority and control of the crown, to administer the new and vast dominion thus acquired. In this way a new province of illimitable possibilities was added to the British empire. The charter bears date October 29, 1889, and, as illustrating the impetuosity with which he prosecuted his now fully-developed railway policy, I may draw attention to the fact that on the very same day Mr. Rhodes signed an agreement with the Cape government to construct a further section of the line to Vryburg. The government itself was indisposed to proceed beyond Kimberley, then a rising trade center. Everything beyond that was regarded as partaking of the nature of rash, if not wild-cat, adventure. They preferred to rest and be thankful. By Mr. Rhodes never rested, and his thankfulness was only for favors to come. His life-work was not to be arrested by the timidity of an unimaginative coast colony. He undertook at his own risk and expense to build the 126 miles to Vryburg, and he built them. It was soon seen that the extension was going to be a financial success, and the Cape, by an act passed in August, 1890, exercised its expropriation rights and took over the line. With the money thus set free Mr. Rhodes, under a second agreement, undertook to construct a further section to Mafeking, and it is characteristic of him that, on this occasion, he left out the expropriation clause, and the section, though on Cape territory, is still the property of the Rhodesian railways.

Pushing still north, under other agreements, he left the old colony at Ramathlabama, traversed the entire Bechuanaland Protectorate to Ramaquabam, and at that point entered Rhodesia, and completed this line to Buluwayo in October, 1898. The capital of Matabeleland, which is 1,362 miles from Cape Town, would have been reached even earlier but for the intervening events of the Transvaal raid of 1896 and the Matabele rebellion of the same date. During this interval Mr. Rhodes had not been idle. Not only was he engaged in opening up railway communication between Mashonaland and its natural port of Beira, but he had succeeded, after a struggle, in obtaining a supplementary charter, in which was enshrined the great principle for which he always strenuously fought, the principle of preferential treatment for British products and manufactures. At this moment, under this charter, which has the force of law, the customs duties on foreign goods imported into Rhodesia can be varied and raised at will. Against the foreigner, therefore, who erects a discriminatory tariff wall against us we have the power of retaliation. But Rhodesia cannot under any circumstances increase her duties on goods of British origin. And the working men of Great Britain who benefit by what we call the "Rhodes clause" should remember with interest that he wrung it from a reluctant government, or, rather, he never gained his point till the advent to power of that great colonial secretary, Mr. Chamberlain.

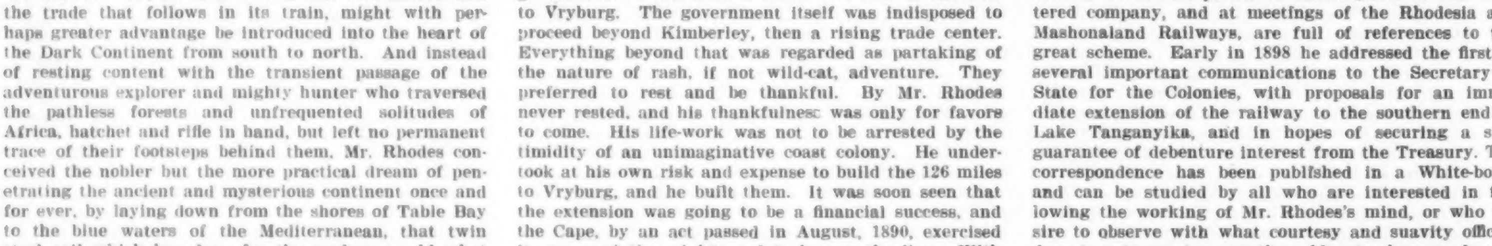
TYPICAL DOUBLE GANGERS' COTTAGE.

From this date onward Mr. Rhodes strove with feverish activity to push the iron rails further on their way. His natural fervor needed no spur, or he might have been spurred by the knowledge he already possessed that he had not long to live. His speeches delivered about this period to shareholders of the chartered company, and at meetings of the Rhodesia and Mashonaland Railways, are full of references to the great scheme. Early in 1898 he addressed the first of several important communications to the Secretary of State for the Colonies, with proposals for an immediate extension of the railway to the southern end of Lake Tanganyika, and in hopes of securing a subguarantee of debenture interest from the Treasury. The correspondence has been published in a White-book, and can be studied by all who are interested in following the working of Mr. Rhodes's mind, or who desire to observe with what courtesy and suavity official departments can turn on the cold-water hose or douche of circumlocution and polite criticism on the projects of men who think in continents. It must suffice to say here that the Treasury was very sympathetic so long as no hard cash was required. But Mr. Rhodes's dreams of empire and its huge responsibilities were too far-reaching for the comprehension of an office like the Treasury, which, not unnaturally, looks more to its British than to its Imperial obligations. Negotiations were practically wrecked on the Treasury demand for a counter guarantee from the Cape Colony, which everybody knew it was impossible to obtain.

The only result of the correspondence was the promise of a moderate subsidy for a limited period. It may

THE UMGUSA RIVER BRIDGE, 56 MILES FROM BULUWAYO.

TYPE OF BRIDGE ADOPTED FOR 50-FOOT SPANS ON THE VICTORIA FALLS SECTION.



CONSTRUCTION PARTY NORTH OF THE ZAMBESI RIVER IN NORTHWESTERN RHODESIA.

THE CAPE TO CAIRO RAILROAD.

* Journal of the Society of Arts.

be convenient here to refer any one who is anxious for further information on this subject to the great speech delivered at the Cannon Street Hotel by Mr. Rhodes to the shareholders of the British South Africa Company on April 21, 1898. In that speech he paraphrased the correspondence in a striking manner:

"What I said to them," he remarked, was "are you not aware that England is nothing without her trade?

TIPICAL CUTTING IN THE WANKIE DISTRICT, 1,545 MILES FROM CAPE TOWN.

It is the trade of the world that keeps you going. I have cost you nothing so far. I do not ask you for anything, but you have exceedingly good credit. If we borrow, we pay 5 per cent. I want two millions to get to Tanganyika. Back my promissory note, and I can borrow at 3 per cent. If you are nervous, raise the money for only 100 miles at a time, and let each 100 miles pay before you go further. You thus get the railway to Lake Tanganyika, and then you have Kitchener coming down from Khartum."

I must here admit that this picturesque phraseology does not appear in the official White-book. It is a free rendering, no doubt, but conveys the substance, if not the literal text, of Mr. Rhodes's communications.

Another of his speeches, which elicited widespread and appreciative comment at the time was addressed to the shareholders of the Bechuanaland Railway Company, on May 6, in the same year, 1898.

It had, I think, a great effect in convincing the public that the Cape to Cairo Railway was not only a national obligation, but would materially benefit British trade. Mr. Bryce remarked that the main value of Rhodesia must be sought in the region of high politics. The Outlook declared that the occupation of Rhodesia would secure our ultimate predominance in South Africa. The Saturday Review pointed out that Mr. Rhodes had grasped the fundamental fact that our island was nothing if not a great workshop, and that the opening of fresh markets was of supreme importance. The Morning Post held that a mid-African railway would extinguish the slave trade for ever.

By other journals it was pointed out that Mr. Rhodes had at one time secured the promise from the King of the Belgians of a strip of land on the frontiers of the Congo State, but that this "way leave" had been withdrawn, owing to the diplomatic representations of France and Germany. It is unfortunately true that by the Anglo-German agreement of July, 1890, a wedge of German territory was allowed to be driven between the Nyanza lakes and Tanganyika, just as by another agreement, equally unwise, the same foreign power was granted access to the Zambesi from the westward by means of an extraordinarily shaped wedge thrust forward into our sphere of influence. A Cape to Cairo line all British was thus rendered impossible by the shortsightedness of ministers on this side, and Mr. Rhodes, bowing to accomplished facts, had to negotiate with Belgium, or, as an alternative, with Berlin. His desire at that date was to extend the rails from Buluwayo to Gwelo, and thence northward over the Zambesi far to the eastward of the Falls, past Lake Bangweolo to the southern corner of Tanganyika. Traversing the lake by a service of steamers, the line would have crossed the strip of foreign territory he hoped to secure, and, entering Uganda at a point between the Victoria Nyanza and Lake Albert Edward, and still proceeding northward, a little to the east of Albert Nyanza, would have linked up Lado and Fashoda with Khartum, and thereafter with Berber and Wady Halfa, and so on skirting the Nile to Cairo. The approximate distance was 6,000 miles, of which 1,800 would have been by waterway. It was an amazingly bold conception, but too imperial for those home-bred politicians who only England know. Only genius can understand genius. Mr. Rhodes in a public office was like the proverbial bull in a china shop, and his project, regarded as revolutionary and, indeed, explosive, was, doubtless, labeled "dangerous," securely fastened up with red tape, and deposited—this side up with care—in that pigeon-hole in the archives where it still reposes. His visits to the Kaiser and King Leopold were unavailing to undo the mischief, though his interview with the former was amusingly characteristic of both parties, and would be found interesting in its details were I indiscreet enough to reveal them.

Foiled in his efforts to strike due north, Mr. Rhodes entered into contracts to extend the line in a northwesterly direction, through the teak forests, and on to the great Wankie coal colliery, a point reached only after his death. From there it was carried to the Zambesi in 1904, the bridge over which being officially declared open by Prof. (now Sir George) Darwin, in September, 1905, in presence of the members of the British Association. Even while the bridge was under construction material was pushed across and the line proceeded with. Kalomo, which is 1,733 miles from Cape Town, was reached in May, Mr. Rhodes's flame of fire having communicated itself to his true friend, the late Mr. Alfred Beit, only lately taken from among us. Beyond Kalomo came some heavy work, notably the erection of a bridge over the Kafue River, the longest, as the Victoria Falls bridge was the highest, in Africa. Under the personal superintendence of Sir Charles Metcalfe, the work never slackened, and in June of this year the first engine ran into Broken Hill. Negotiations are now in progress for the construction of another section to a mine called Bwana M'Kubwa, and it is an open secret that a further extension to Kansanshi is under consideration, which would bring the line to the extreme northwest border of the chartered company's territories. The greatest credit is due to those who, through evil report and good report, have financed the railways, to Messrs. Sir Douglas Fox and partners, their consulting engineers, to Sir Charles Metcalfe for his untiring personal services, to Messrs. Pauling, the sole contractors, to Mr. G. A. Hobson, who superintended the building of the great bridge, and to many other brave hearts and willing hands.

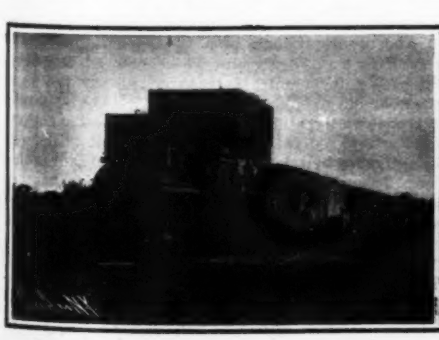
What will happen when our boundaries are at length reached it would be premature to conjecture. A large and highly mineralized area—that of Katanga—is reported to exist in the neighborhood, but as this is a sober relation of known facts, read before a learned society, and does not partake in any way of the nature of a prospectus, I refrain from indulging in those glowing predictions which might be appropriate and customary were I inviting you to subscribe to an issue of additional capital. But that the Cape to Cairo Railway will be abandoned I refuse to believe. There may be delay, but no prolonged or permanent abandonment of the project. The age is not so prosaic as some people imagine. Romance still exists, and men are still swayed by master minds and great ideas. There are still influential circles in which, as occasions arise, the question is sympathetically put, "What would Mr. Rhodes have done?" The continuity of his policy is thus assured. Whether or not the whole line is completed in our time, the glory of its inception and of its partial construction must in justice remain with Mr. Rhodes. Helped he undoubtedly was by able and loyal co-workers, but without his imagination and insight, without his shrewd business instincts, without his dominating personality, very little progress would have been made. Already the direct and indirect advantages accruing from the line are incalculable. It

THE LUXURIANT COUNTRY THROUGH WHICH THE ROAD PASSES AFTER CROSSING THE VICTORIA FALLS.

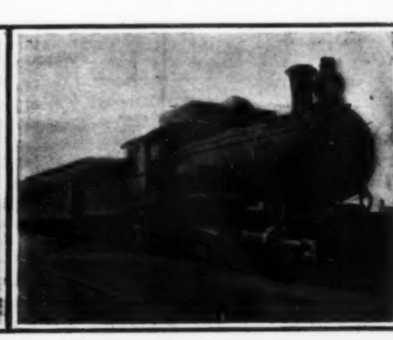
is sometimes scornfully asked whether the traffic between Cape Town and Cairo will suffice to pay the cost of grease for the axles of the wagons, and whether any sane man who makes the through journey once will ever desire to make it again. These cheap pleasantries do not ruffle our feathers. Mr. Rhodes was no fool, and he never anticipated that the through traffic would pay debenture interest on construction; what he rightly relied on was the immense stimulus that the line would give to internal development, to cultivation of the soil, exploitation of minerals, greater facilities for occupation of land, and consequently a steady growth of the white population. That he was justified in his forecast I think no one will deny, though the progress made in these directions may be less rapid than an old man in a hurry, like myself, might desire.

Prince Adolphus Frederick, lecturing last month before the German Colonial Society at Berlin, referred with admiration to the improvement visible in British trade on and around the Victoria Nyanza, which he attributed to the construction of the Uganda Railway. He stated that when he first visited the district four years earlier there were practically no white settlers. Now they were pouring in, and fresh applications for land were being daily received. Traffic on the lake, in consequence of the railway service, had largely developed, and new steamers were being built in England to cope with it. In conclusion he held up our example as a model to his own German countrymen, an unusual and quite refreshing tribute which I could not refrain from quoting to you.

Always remember, that the British possessions in South Central and Central Africa embrace the bulk of the great plateau of the continent, a plateau averaging more than 4,000 feet above sea level, and hence suitable for occupation by Europeans, provided they



TEMPORARY WOODEN WATER TANKS AND NEW OVERHEAD CAST-IRON TANK OF 30,000 GALLONS CAPACITY.



STANDARD EIGHT-COUPLED LOCOMOTIVE OF THE CAPE TO CAIRO RAILWAY.

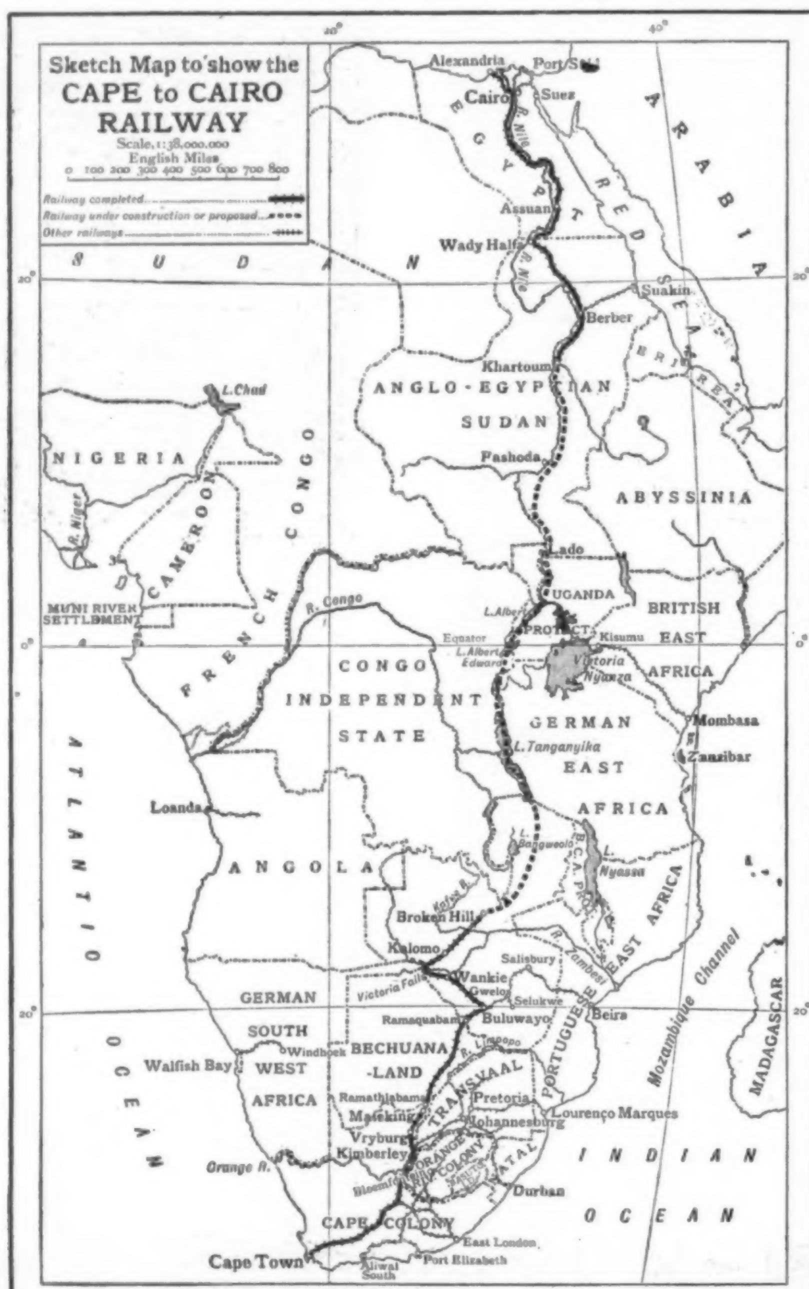
THE "TRAIN DE LUXE," ZAMBESI EXPRESS, WHICH RUNS BETWEEN BULUWAYO AND CAPE TOWN, A DISTANCE OF 1,736 MILES.

THE CAPE TO CAIRO RAILROAD.

are afforded the necessary railway communication to and from the coast. Take the case of Rhodesia alone. Vryburg, where our line begins, is at an elevation of 3,890 feet; Buluwayo, the principal town of Matabeleland, is 4,469 feet; Salisbury, the capital of Southern Rhodesia, 4,825 feet; while the Melsetter and Inyanga districts, from which an export of merino wool has already commenced, stand at between 6,000 and 6,500 feet.

Over the Zambesi, in Northwestern Rhodesia, formerly known as Barotseland, the plateau is still preserved. Kalomo, the chief town, is 4,090 feet above the sea; Broken Hill, the present terminus, is 3,988 feet above the sea. If we turn to Northeast Rhodesia, we find the great Tanganyika plateau, much of it 5,000 and 6,000 feet above sea level, while the altitude of Sunzu has been stated by Mr. L. A. Wallace to be 7,393 feet, of Mamitawa, 7,239 feet, while the Nyika plateau rises to 8,500 feet.

This is not a gathering of the Statistical Society, but I have troubled you with these figures because they do bear on the question of railway development and land settlement. The Cape to Cairo line is not a jungle line traversing steaming valleys and malarial swamps. It aims at conforming as far as possible to the route recommended by engineers, and what is it nowadays that engineers cannot do? It aims at following the contour of the African watershed, and I do not hesitate to affirm that, where the railway runs, there for the most part white people can settle, and in increasing numbers will settle. Thanks to medical science generally, thanks probably to the Liverpool Tropical School of Medicine in particular, the origin and treatment and even prevention of malaria are becoming facts easily obtainable. Mr. Rhodes lived to know this, and he relied, therefore, on ultimate closer settlement, and on the growing value of local or inter-station traffic in regard to passengers, merchandise and produce. The native races are childishly fond of traveling by rail. Throughout South Africa, they are a traffic manager's best customers. It is true they do not travel first-class, indeed they only travel third, because there is no fourth, and, by preference, they would travel in open trucks with their bare legs dangling over the side. But they are consistent travelers. They travel on the slightest provocation, or on no provocation at all. I have seen them in troops arrive at a terminus, and cross over at once into a return train, thoroughly enjoying themselves regardless of blazing sun and dusty track, for they do not take their pleasures sadly, as we are accused of doing. Then, of course, cheap, quick, transmission of labor is facilitated by the railways, which are in this and many other ways, a great developing and civilizing factor. Some of you here may have witnessed what I have often seen in the old days, natives walking literally hundreds of miles in search of work. Scant of clothing, short of food, ill, weary, and footsore, they were sustained only by that incomparably sunny temper which characterizes the aborigines of the Dark Continent. Now they ride by rail and enjoy themselves. I remember seeing amid the early morning mists enshrouding the Barberton hills, a shadowy troop of Shangans, some of them in the last stage of emaciation, gliding like unsubstantial ghosts, toward the close of a long toilsome trek, to seek work at the Sheba mine. And though alien to my subject, may I add that on arrival there, when the strongest were taken on and the physically unfit rejected as useless, the former invariably shared his rations with the weaker brethren. Wolfishly hungry the workers were, but half their mess allowance went to those who, without it, would have died of sheer starvation. No ethical or moral deduction should be drawn from the incident. The untutored savage was not a Christian or even a philanthropist. He was acting on strict business principles in order that the invalids might the sooner become wage-earning units, and thus add to the wealth of the whole group.



In other parts of South Africa I have seen natives on trek to or from their labor area so utterly worn out by excessive fatigue that to all appearance their wanderings in this world were well nigh over for ever. Much of this will be mitigated or avoided by the Cape to Cairo Railway and its subsidiary feeders. Labor will now have fair play. The mineral and agricultural development of Rhodesia and districts further south will be immensely facilitated by the great trunk line, and its use will save the native from untold distress. More distant areas will be tapped, new industries will arise, new wants be created, and the whole of Africa will eventually benefit from the extension of the line. A great army of sightseers, missionaries, scientific investigators, sportsmen, boundary commissioners, police, and civil officials, will also reap the advantage of quicker communication with the interior.

But it is, of course, on goods and produce that the line has mainly to rely, and the chartered company is now devoting its energies to the task of attracting white settlers, by whose co-operation trade and agriculture, as they develop, will gradually place the railways on a payable basis.

Need I add here that among the many services rendered by the railway it has rendered accessible to the world, or to that portion of it which travels, the grand waterway of the Zambesi and its mighty falls, across which it runs on a mighty bridge of a single span, designed by one British firm and built by another, and its construction supervised by a British engineer—a structure so noble in its proportions, so delicate in its tracery, that it will remain an imperishable tribute to the skill of our modern bridge builders.

Here, too, the railway scores another triumph, for it is rendering practicable that great conception of utilizing the water-power of the Zambesi to generate electric energy on economic lines over a distance double that attained in America: so that one of the assured events of the near future is that the eternal thunder of the great falls at one end of the wire will ere long be matched, at its other end, by the roar and crash of the many thousand head of stamps employed by night and day in the largest mining center in the world.

For my part I foresee the time when our achievement in bridging the Zambesi will appear but an incident in this great undertaking. We are already out of the hearing of the roar of the Victoria Falls; already beyond the furthest point which owned the Matabele sway. We are already in the heart of Barotseland, and practically nobody, in this age of progress, can say to us: "Thus far shalt thou go and no farther." We are investigating the economic value of our teak forests for wood-paving the streets of colonial towns; we are hoping to exploit the waters of the Zambesi for carrying electrical power to Johannesburg; we are sending down gold and diamonds for use and ornament; we are working our railways with our own coal; we are beginning to ship zinc and lead ore from Broken Hill, and ferrochrome ore from Selukwe to harden steel plates for the British navy, and, finally, we shall ship copper for your telephone wires, and rubber for your motor-cars. All this actual and potential traffic is due to the waking dream of one great man. Here, at the heart of the empire, no statue has arisen to the arch-imperialist, but travel in South Africa and you will feel his spell; you will look around you and see his monument; a monument more durable than brass, for it is the monument of high achievement, and of duty nobly done.

We shall soon, from the observation car of a railway carriage, look out upon the Congo State. Are we to stop there? It is unthinkable! Mr. Rhodes would not have stopped there. After his manner I seem to dream. I see, as in a vision, a thread-like, serpentine double rail athwart the entire continent. South to north I see the colored races being conveyed to and from labor centers in health and comfort. I see our crowded and over-crowded areas here pouring out thousands of white men, to build, as Mr. Rhodes wished, "more homes" under brighter skies and happier conditions. I see additional employment here for our own people in manufacturing articles for those who have transferred their domicile to Rhodesia and Central Africa. I seem to see long streams of wagons made in Birmingham and Lancaster, drawn by powerful engines made at Leeds and Glasgow, traveling from the Cape of Good Hope or Beira, ever northward, over rails made in South Wales, and conveying mining machinery, agricultural implements, and articles of necessity, and eventually of luxury, from every manufacturing town of Great Britain. And I see those same wagons coming south, laden with coal, copper, and many other minerals, with timber, wool, and hides and skins, with ivory, tobacco, cotton, rubber, ground-nuts, valuable fibers, and other products of a sub-tropical country. I see the silver tie of sentiment which now binds Britain to her African colonies, strengthened by the even stronger band of mutual trade interests. I see the slave trade finally and for ever eliminated from those remote corners, so full of cruelty where it still flourishes. I see Christianity and civilization advancing northward hand in hand, to found in Africa another of the vast empires of the world and of the dim future, whose originating center will be these islands of ours, at once so small and yet so great. And, as I dream, I seem again to see the wonderful man who now sleeps his last sleep amid the granite kopjes of his own Matoppo Hills. He is at length at rest, but his face is looking northward; and we do well to remember him who, in his all too short life, gave to us, amid many high and fruitful ideas, the wonderful conception of a railway from the Cape to Cairo.

On one point the progress of the railway is watched in certain quarters with feelings of apprehension, and I will not deny that the apprehension is justifiable. We are, as we go forth, approaching that central tract of Africa which is being devastated and depopulated by that terrible scourge, the sleeping sickness. The danger feared is that easier, quicker, and more continuous intercommunication may tend to spread the disease to other centers. I can only say that we are alive to the risk, and if, as the Royal Society pointed out last week, the British South Africa Company, with all the immense financial responsibil-

ties resting on it, has recently spent £36,000 in helping science to determine an arc of the meridian, we shall not grudge time, nor trouble, nor expense to protect the white and native populations of the territories within our jurisdiction from the horrors of the sleeping sickness. I have myself within the last few days had an interview with Dr. Todd, than whom there is no higher authority, and he has pointed out the nature of the precautionary steps to be taken to discover and isolate cases and prevent any extension of the area which the disease afflicted. For my part, I venture to think that, with intelligent care, the railway may help and not hinder the devoted medical men engaged in fighting the sleeping sickness, sometimes, as in the case of Dr. Tulloch, at the risk of their own lives.

Before bringing this paper to a close, let me remind you that, while our progress to the north has been fairly rapid and reflects credit on the financiers, engineers, and contractors, it is not the only progress that has been made. I have already quoted Mr. Rhodes's strikingly picturesque dream of "Kitchener coming down from Khartum." Lord Kitchener has long since left Egypt, and served his country well in another part of Africa, but his spirit still haunts the land of the Pharaohs—the strong will still seems to dominate the Soudan. There, too, the railway progress has been considerable. From Cairo or Alexandria southward to Assuan, a distance of 590 miles, the line is constructed, and another 560 miles between Wady Halfa and Khartum, while a further extension of 410 miles to Usambara is, I believe, projected. In the aggregate, the line from the north, completed or contemplated, is thus about 1,600 miles, and from the south rather more than 2,000 miles. Add to this the long Tanganyika waterway and you will see that the great enterprise is already far advanced. I do not believe that the courage and tenacity of our race are failing us, and some of those here present to-night may live to see the land of the Pyramids and the Sphinx linked up with that cape of storms now called the Cape of Good Hope, round which that intrepid Portuguese sailor, Vasco da Gama, drove his crazy barque a little over 400 years ago. I have finished. I trust I have not wearied you. It has been my aim to avoid the dry bones of tabular statistics, but to give you, in very general terms, an outline of the origination and partial completion of a line destined, in my opinion and, I trust, in yours, to regenerate a continent, to bring peace and prosperity to Africa, and an expansion of trade to the country whose citizens we are and whose faithful servants we are proud to be.

THE VALUATION OF BREAD.*

BREAD FROM SIFTED FLOUR OR BREAD FROM THE ENTIRE GRAIN?

By DR. A. KUELLENBERG.

THE number of different kinds of bread existing in commerce is very large. The diversity is less due to the raw material—as mostly wheat and rye are used—than to the preparation of the cereal as well as to the baking process. There are various, strongly contrasting views upon this subject. Some demand a more thorough perfection of the old mill process, others want to use coarsely ground grain only, with or without a larger or smaller percentage of bran; others again grind the grain to a dough after it has been allowed to germinate; and many have constructed complicated machinery in order to pare the grain before grinding. This latter process is not only supposed to yield a larger amount of flour, but it is also claimed to improve the quality of the bread considerably, especially so in the case of rye bread. Then there is bread prepared with the admixture of gluten or other nitrogenous substances in order to increase the food value of the bread; some of these are of importance for the nutrition of invalids, others are proposed for the purpose of supplying the most nutritious food at the lowest cost, as, for instance, in the provision of soldiers.

There are innumerable types of bread, making the valuation of the same not always an easy task; we must not only take into account adulteration of all kinds, but also the method of preparation and the purpose for which the bread is intended.

Bread must be prepared from pure flour with the use of good yeast or sour dough. The crumb should be neither sour (use of too much sour dough) nor soggy (use of flour from germinated grain or defective kneading of dough). It should be rather elastic and porous and should not contain any ungelatinized flour clots. Bad odor, especially due to mold growth, should always be condemned.

The chemical analysis of a bread embraces mainly the determinations of moisture, degree of acidity, carbohydrates, proteids, and crude fiber. This should naturally be supplemented by microscopical examination. The amount of moisture should not exceed 45 to 50 per cent; bread with a higher percentage of moisture must be considered defective. The percentage of ash or mineral matter should be not higher than 2.5 per cent after subtraction of the salt; higher amounts indicate foreign additions such as barytas (barium sulfate), copper, zinc, or aluminium salts; these are sometimes added to flours which have lost their property of forming a good adhesive dough in order to increase their kneading capacity. The acidity should be neutralized by 3 to 5 cubic centimeters of normal caustic soda for each 100 grammes of bread; Lehmann† considers 7 to 10 cubic centimeters normal alkali as a maximum limit of acidity. The determinations of carbohydrates and proteids present a fair picture of the approximate, relative food value of the bread.

For the recognition of adulteration with flour from weeds or inferior cereals the microscopical examination is the only decisive factor. The addition of rye to wheat flour may thus be readily ascertained by the distinctive structure of the layer of cross cells. If possible, the microscopical examination should be made of the flour from which the bread has been prepared, as sometimes the structure of many elements and especially the characteristic form of the starch grains may be considerably changed by the baking process.

It is true that on the strength of such chemical and microscopical examinations many conclusions may be drawn regarding the valuation of a bread; nevertheless there still exists a wide gap of criteria for its perfect valuation. All these figures do not give us definite information to what extent those in the bread existing nutritive elements may be made available for absorption in the body. Sometimes the chemical data may even give rise to erroneous conclusions regarding the food value. This is especially true of the protein figures. The bran and the so-called gluten or aleuron layer is richer in nitrogen than the meal body; consequently the bran bread shows a higher percentage of nitrogen than the white bread. Notwithstanding this fact, however, the white bread must be considered as the more nutritious of the two. This has been recognized since the digestion experiments with different kinds of bread. Exhaustive and determinative tests were first made in this direction by Voit, Rubner, Lehmann, and in recent times by Plagge and Lebbin.

Such nutritive experiments are generally conducted in the following manner: The experimental person is nourished for several days exclusively with the bread to be tested; the bread is accurately weighed and the percentage of moisture, dry substance, protein, carbohydrates and fat is exactly determined.

This permits a calculation how much of the different nutritive substances has been absorbed by the individual during the entire period of the experiment. The fæces are weighed and examined in the same manner. They contain the non-absorbed, nutritive elements which are, of course, without value for the nutrition, having passed the body unchanged. As the total amount of the various nutritive elements is known from the analysis of the bread, the loss in percentage may be calculated from the fæces. The line of demarkation in the fæces from the bread and those from the previously or afterward administered food is ascertained in the following manner: Before the experiment and after conclusion of the same, some food is given to the individual that will produce fæces totally different from those of the bread. In most cases milk is employed for this purpose or sometimes also cranberries, huckleberries, or blueberries, the peel of which will pass the stomach undigested and may thus be recognized in the fæces. If diarrhœa does not occur it is possible to always distinguish sharply between the different fæces.

The following table contains a number of results from such digestion experiments. The first four were made by Voit, the other four by Plagge and Lebbin. The figures represent the percentage loss of the various nutritive elements:

Kind of Bread.	Dry Substance.	Proteids.	Ash.	Carbohydrates.
1. Horsford-Liebig bread..... (Whole grain)	11.5	32.4	38.1	....
2. Munich rye bread........	10.1	22.2	30.5	....
3. Munich wheat bread......	5.6	19.9	30.2	....
4. Oldenburg Pumpernickel.. (Whole grain)	19.3	42.3	96.6	
5. German army bread...... (Rye with 15 per cent bran)	13.2	43.35	....	8.32
6. Bread from fine rye-flour with 25 per cent bran...	9.49	33.75	....	5.61
7. Westphalian Pumpernickel (Entire grain)	15.66	52.04	82.58	....
8. Bread from finely pulverized pure bran	42.71	53.55	73.38	....

As may be seen from these figures there exists a remarkable difference concerning the availability of the nutritive elements from the various kinds of bread.

The largest amount of nutriment is derived from the white; that is a bread from good, bran-free wheat flour; these results have been corroborated by repeated experiments. Less available nutrition seems to be contained in a bread from good rye flour, and a bread with a larger percentage of bran is still inferior in its nutritive value. Of particular interest are the experiments made by Plagge and Lebbin with the bread prepared entirely from bran flour. Adherents of bran breads have often claimed that the low nutritive value of these breads is entirely to be attributed to the insufficient comminution of the bran. In order to prove this assertion, bread was prepared from pure bran flour that had been pulverized as finely as possible; this was then fed to the experimental individual. The tabulated figures give sufficient evidence that the nutritive availability of this bread is extremely low. Even if in a natural mixture of bran and white flour the finely pulverized bran would perhaps be made more available for nutrition, this experiment shows conclusively that the nutritive value of bran flour is very low. Moreover, the fine comminution of the bran presents considerable technical difficulties; it seems therefore very doubtful whether this process will ever be adopted as a rational method of bread-making.

Is, however, the bran entirely without value for nutrition? This question must certainly be answered in the negative. Although the bran itself does not represent an ideal food, it can by no means be asserted that bread from unbolted or unsifted flour has no claim for existence.

The digestion experiments with entire grain bread as well as with those containing a small percentage of bran are at a disadvantage in comparison to the white bread. We must consider that these experiments are more or less algebraic calculations which cannot express one factor playing an important rôle in all practical nutrition and one that cannot be determined by calculation, namely: agreeability of taste and palatableness.

It is by no means indifferent whether a bread possesses a more or less agreeable taste; it is rather a stimulus to a good digestion, if food is eaten with a certain degree of relish. Bread should not only contain the necessary nutrients, but it should also possess a certain amount of appetizing relish. In this respect there exists a remarkable difference between these two classes of bread. Generally breads from the entire grain possess a specific, wholesome, and substantial taste, that is very much relished by most people and many prefer it to the insipid, neutral taste of the white bread. Although this cannot be asserted of all breads of this type in commerce, there is no doubt that the better kinds of bran breads have a more appetizing and agreeable taste. It is not surprising, therefore, that this method of bread making has enjoyed such an extensive growth.

It appears also that this bread is of some significance from the hygienic standpoint, as many, suffering from the most persistent habitual constipation, have often been restored to normal health by a diet of bran bread. Dentists claim that the frequent chewing of coarse bran bread keeps the teeth in a healthy condition, as it supplies the sufficient measure of work so necessary for the maintenance of every living organism; this is only required to a small degree in the chewing of the soft, white bread containing no hard constituents except the crust.

Notwithstanding all these facts, however, the author does not believe that the preparation of bread from the entire grain will ever supplement the old system of bread making. This is not only due to the habit cultivated through centuries, but in a large measure attributable to the fact that the exclusive diet of such bread would not seem desirable from the hygienic standpoint generally. The eating of larger quantities of whole grain bread would in most people create an abnormal stimulation of the intestines, causing the food to be digested and absorbed too rapidly. This too energetic acceleration of the digestive operations would necessarily cause a considerable loss of nutritive elements as well as a decreased absorption of the entire food in general. From an economical standpoint it may further be said that it is entirely unrational to employ the total amount of bran for the preparation of whole grain breads for human food. We know that the bran is utilized far better by the cattle, and nothing will be changed by the bold calculation of the adherents of whole grain bread who claim that, for instance, Germany could supply its total want of cereals from its own resources if it would adopt this method of bread making.

In view of all these facts, how may we be enabled to judge a bread properly? It seems especially requisite to ascertain in every case the purpose which the bread is supposed to serve. If it is a question of feeding large numbers of strong, mostly young people, as, for instance, in the provision of armies, a bread with less available nutrient elements may also be recommended as an exclusive bread diet. It may be justly assumed that such a bread, eaten together with other food and especially by strong, young people, is better utilized as may be supposed from the experiments made with bread exclusively, so that the above-mentioned disadvantages would not occur to any notable extent.

The valuation of bread becomes an entirely different problem if the bread is given as a diet for sick, old people or invalids. In this case, with the exception of individuals with chronic constipation, the bran-free, white bread should always have the first preference. The simultaneous use of entire grain bread is always recommendable as a great many people apparently enjoy the joint diet of both kinds of bread. It seems more wholesome for most people not to confine themselves to one kind of bread. The proportional quantities of the different types of bread depend entirely upon the individual taste to which just as much weight should be attached as to the digestion experiments. The former should also be quite as decisive in the valuation of bread containing specific nutritive additions. If such breads are disagreeable or unpalatable they would have failed their purpose from the start.

The taste is the natural regulator of all our diet, qualitatively as well as quantitatively. Any diet, may it be ever so rational from the scientific standpoint, will have entirely failed if it is permanently maintained with aversion.

* Pure Products.

† Arch. f. Hygiene, 1893, 19, 363.

BEET SUGAR MANUFACTURE IN ITALY.

THE process employed, whereby an annual home consumption of over 100,000 tons is produced, is interestingly set forth in a recent issue of The Engineer (London), from which we abstract the following:

"The roots, transported to the factory, are weighed and discharged into great brick silos about 330 feet long, made in the form of a V, and being about 26 feet broad at the top and 20 feet at the base. Under the floor, made of movable wooden beams, runs a strong stream of warm water, which is turned on when it is necessary to empty the silos. The wooden beams are then drawn out one by one, the roots fall into the hot stream, and are carried by it into the

factory, arriving there by this means partially washed. Then, after a complete cleansing, they pass automatically into an elevator, which raises them to the upper story of the factory and discharges them into the automatic weighing machine, which receives the flow of roots up to a given weight—usually about one ton—discharges the load, and returns to its place for a new one. A dial registers the number of loads weighed.

"After this second weighing the roots pass to the cutting machines, which consist, as a rule, in disks of about 6.5 feet-diameter, revolving 80 turns a minute in contact with steel knives having a corrugated cutting surface, and somewhat resembling the blades of horse-clippers on a large scale. Impelled by their weight on to these revolving disks, the roots are cut by the knives into small quadrangular or triangular strips called 'fettucce,' which are discharged from the bottom of the machine; and so rapidly is the work performed that each one of these cutters can transform in 24 hours 400 tons of root into 'fettucce.'

"The old systems of compression and crushing having been entirely abandoned in favor of the 'diffusion system' discovered by Robert, the 'fettucce' now pass into the 'diffusion battery,' consisting of a series of from ten to eighteen diffusers. These diffusers are hermetically-sealed recipients in which the 'fettucce' are brought into contact with water heated to a temperature which varies progressively in direct ratio with the state of exhaustion of the said 'fettucce.' The liquid emanating from each diffuser passes by means of a tube to the next one, where it meets with less exhausted 'fettucce,' and, by this means, doubling the potentiality of its saccharine matter at each stage, issues in the form of a yellow sluggish liquid, the immediate ancestor of the white sugar of commerce.

"The exhausted 'fettucce,' called 'polpe,' are washed and are then sold, either in the dry or wet form, to the farmers for the fattening of oxen.

"The yellow liquid that issues from the diffusion battery contains as yet many impurities which must be eliminated before it can be turned into the sugar of commerce. The first stage of its regeneration consists in passing through a fine metal sieve, and in thereby purifying itself of the small percentage of solid material which has found its way through the labyrinth of the diffusion battery. The liquid is now heated up to about 150 deg. F., in order to render insoluble those substances which under the action of heat precipitate albuminoids, is then mixed with a certain quantity of milk of lime, and afterward purified by two processes. The first of these consists in treatment with lime for the purpose of separating the sugar from other non-saccharine ingredients; the second in the treatment with carbonic acid in order to purge the sugar of the lime. The iron lighthouse-looking towers which the traveler sees on his journey between Ferrara and Ancona are the furnaces destined to supply the quicklime and the carbonic acid gas necessary for this latter purpose.

"The process of 'saturation' may be repeated twice, or even thrice, and then the liquid is passed through filters made of jute fiber, and the scum is sold for the manuring of alluvial soil. The filtered liquid is by this time almost pure sugar in solution; to crystallize it evaporation is necessary. This is performed as in all modern plants in multiple-effect evaporators.

"On its exit from these the primitive yellowish color of the liquid has deepened into a vinous brown; the alkali remaining is saturated with carbonic acid, and

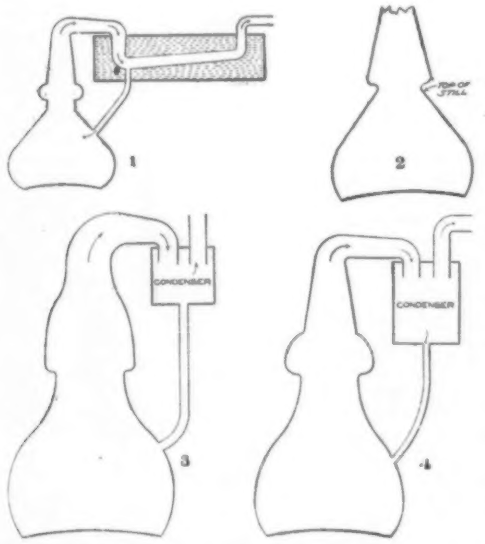


Fig. 1.—FOUR TYPES OF POT STILLS USED IN THE NORTH OF SCOTLAND.

the precipitate obtained is again filtered. After this it is subjected to heat in order to evaporate the already concentrated solution, and is then crystallized. For the formation of large crystals—the object in view—this latter operation requires the greatest skill and experience possible. The molasses is now separated from the crystals by means of centrifugals revolving at from 800 to 1,200 turns a minute, and the finished raw sugar passes to the refinery, where the crystals are again dissolved, clarified, and re-crystallized, issuing from the works in the various forms and qualities of the beetroot sugar known in commerce."

THE WHISKIES OF GREAT BRITAIN AND IRELAND.*

By Dr. H. W. Wiley.

SCOTCH WHISKY.

Malted Barley Distilleries.

There are two kinds of distilleries found in Scotland—those producing grain spirits and those using malted barley only—but by far the greater number belong to the latter class. These distilleries are divided into four groups, according to location, and the number of distilleries in each group is about as follows: Highland and not classified, 108; Lowland, 33; Campbelltown (island of Kintyre), 21, and Islay, 9. This is

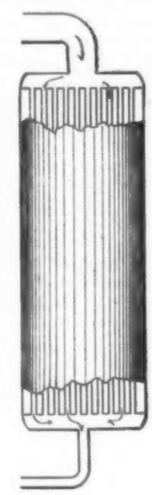


Fig. 2.—MODERN FORM OF CONDENSER, SCOTLAND.

only an approximate classification. Many changes take place in the number of distilleries in active service, and the classification is by no means perfect. These figures, however, give a general idea of the distribution of the distilleries.

Much of the barley used is home grown, but the amount available is insufficient, and considerable quantities are imported from Denmark, Hungary, and the United States. The California barleys are highly prized because they can be used in the early part of the distilling season—that is, in September—before the home-grown barleys are sufficiently dry. Often the barley in the north of Scotland is not all harvested until late in August.

Malting is generally conducted in the old-fashioned way, by steeping the grain until thoroughly moist and spreading it on cemented floors well protected by heavy walls against the cold. Even in winter the malting takes place without any artificial heat. In very cold weather the layers of grain are made thicker on the floor and the heat of germination prevents freezing. The lower the temperature at which the malting takes place the better the product, though the time required is longer. From ten to sixteen days are usually required to complete the germination. In some cases the malting is accomplished by the so-called pneumatic process, in revolving drums which move very slowly, so as to keep the sprouting grain gently stirred. A current of air is drawn through the apparatus and this air is warmed or cooled and made wet or dry according to the indications of the thermometer and hygrometer. This method was found in use in only one of the distilleries.

After the germination is completed the malt is dried by being spread on a perforated tile or wire floor over an open fire fed by peat and anthracite coal or coke. The peat is specially prepared and is kept dry for a year or more before using. The older peats are said to give the finest flavors to the product. The empyreumatic emanations from the smoldering peat are absorbed by the malt, subsequently dissolved in the mash, and pass over into the distillate, imparting thereto the much-prized smoky flavor so well known in Scotch whisky. The use of water which has filtered through the peat bogs is also deemed of great efficacy in distilling the finest Scotch and Irish whiskies. Some of the kilns are made with double floors, the second placed about 5 feet above the first. The green malt is placed on the upper floor and let down to the lower as soon as the charge thereon is removed. This practice, however, is by no means general. The malt is dried until the moisture is reduced to 2 per cent or less, care being exercised to avoid any burning. To this end the layer of malt is frequently turned during the process. Considerable quantities of malt are kept in store, and it is generally believed that old malt makes a better product than new.

After grinding, the malt is mashed in large vats furnished with stirring machinery, which keeps the mass in constant motion. The mass is gradually heated, but not above the point of the activity of the diastase, 140 deg. F., at least until the starch is all converted. The bottom of the mash tun is finely perforated, so that when this operation is completed the liquid part of the contents may be drawn off to the coolers and the residual grains separated for cattle food. These grains are sold in a moist state for neighborhood consumption or dried for shipment to a distance. The hot wort is passed over coolers and run into the fermentation vats, called "wash backs." To the cooled wort the yeast is added and the fermentation conducted at ordinary temperatures. The fermentations are finished in from forty-eight to seventy-two hours and the beer is then ready for distillation.

In all of the distilleries inspected the distillation is conducted in pot stills heated over an open fire. The stills have necks of various shapes and sizes. In some cases the neck passes in a horizontal position to the worm, immersed in flowing water, and the products of any condensation in this horizontal section are returned by an attached pipe to the still. This is by no means a universal arrangement, however. The stills are usually arranged in sets of three, one large beer still for making low wines and two smaller low-wine stills for making the high wines or crude whisky. In the beer or wash still is found a scraper, usually in the form of a chain, properly fixed to revolving arms which fit the convex inner surface of the bottom of the still and prevent the deposit and burning of solid matter during the distillation. This scraper is operated by a perpendicular shaft passing into the center of the still, usually with an air-tight journal in the top of the neck.

The accompanying illustrations (Fig. 1) show some of the variations in the form of the stills used at the different distilleries in the north of Scotland. Much stress is justly laid by all distillers on the shape of the still, and it seems very probable that the character of the whisky is markedly affected by its form and the length of the neck, controlling as these factors do the incidental rectification which takes place during the distillation.

The still shown as No. 1 in Fig. 1 is covered with a non-conducting material said to effect a considerable reduction in the quantity of coal used. There are two sets of these stills, heated over an open fire, a wash still and two low-wine stills comprising each set. The neck of the still has an enlargement near the bottom, instead of being regularly horn shaped, as were those in Glasgow, and the horizontal portion of the neck is provided with a condensing jacket.

The type shown as No. 2 in Fig. 1 has no covering, though heated over an open fire, and no condenser in the horizontal part of the neck. The neck is peculiar in shape, having straight conical sides until it assumes a horizontal position, and is rather shorter than usual, not exceeding 10 feet. There are two sets of stills, of which the wash still holds a little over 6,000 gallons and the low-wine stills half that amount.

Another modification is shown as Nos. 3 and 4, Fig. 1. Instead of the horizontal jacketed neck piece, the very large neck ends in a vessel which acts as a condenser, being surrounded by a jacket containing water, and from which the products of condensation return directly to the still. The low-wine still differs slightly in shape from the wash still, but is constructed on the same principle. The stills are heated over an open fire, as in the other cases. The newer set of stills at this distillery have a condenser composed of a large number of small copper tubes placed in a cylindrical vessel through which alcohol flows (Fig. 2). This form of condenser takes up much less space than the old form and is considered quite an improvement.

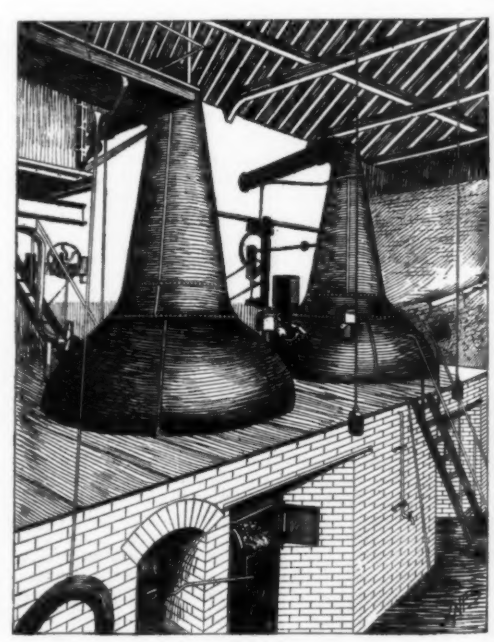


Fig. 3.—SCOTCH POT STILLS, SHOWING INSTALLMENT.

The distillation is carried on until the alcoholic content of the distillate becomes too low for use as low wine. The residue is then distilled until the alcohol is all run off, and this portion of the distillate is added to the next charge of beer. The spent beer is disposed of in various ways. It is not permitted to discharge this by-product into running streams because of the pollution which is caused thereby. If possible, it is sold for cattle food, but it is not highly prized for this purpose. Sometimes it is settled in cement tanks sunk in the earth and the solid matter is used as manure. In some distilleries it is put into septic tanks and de-

* Abstracted from Bureau of Chemistry Bulletin No. 102, published by the United States Department of Agriculture.

stroyed by bacterial action; in others furnaces are erected in which the spent beer is burned.

The low wines are conducted to the small stills and subjected to a second distillation for the purpose of bringing them to an alcoholic strength suitable for bonding, namely, from 55 to 60 per cent by volume of alcohol. The first parts that come over are very rich in alcohol, and as the distillation proceeds the alcoholic strength falls. When the distillate, after mixing, reaches the strength desired, as given above, the remainder of the distillate is collected in a separate vessel and mixed with the low wines of the next charge. When the alcohol is all over, or nearly so, the lees are drawn off, treated as spent beer, and the still recharged with low wines plus the low alcoholic residues from the previous distillation. Thus practically all the volatile matters are finally collected into a spirit of from 55 to 60 per cent by volume of ethyl alcohol. The lees and spent beer of course contain more or less of the alcohols and other bodies of high boiling points and in this way a portion of such bodies is removed. There is always enough of them, however, to give character and flavor to the distillate and provide those bodies which in the process of aging give the distinctive flavor and value to the product. Every part of the process is controlled and checked by the excise officers, whose lock and seal are kept on every valve and other opening whence any of the spirits might be surreptitiously withdrawn. Fig. 3 gives a general view of the installment of two Scotch pot stills.

The spirit is stored in oak casks, and those in which sherry wine has been matured are particularly sought after. A good sherry cask often sells for as much as 50 shillings. The sherry wood is said to yield a peculiar and desirable flavor to the whisky, and also to impart a deeper color thereto than is given by the plain wood. Previous charring of the inside of the plain wood barrels is not practised, and these casks color the spirit very little even after the lapse of five years.

Whisky made in the manner just described is genuine Scotch whisky, and it is doubtful if any other product, without some qualifying word, is entitled to bear that name.

Grain Spirit Distilleries.

The grain spirit, or silent spirit, distilleries, while not numerous, are of very large capacity, and without doubt make more gallons of spirit than are produced by the hundred and more malt distilleries. The grain spirit distilleries are by no means all in Scotland. Many of them are in England and Ireland, and the products are used for mixing with malt whisky.

The grain used in these distilleries, as far as could be ascertained, is without exception Indian corn imported from the United States. The process employed is extremely simple. The Indian corn is ground, mashed with sufficient malt to convert the starch into sugar, fermented in the usual way, and the beer thus produced is run at once into a so-called patent still. The patent still is composed of two parts, the first a complex system of copper pipe 6 inches or more in diameter, and in a still of moderate size a mile or more in length (5,000 to 6,000 feet), built up in parallel layers into a column 50 feet or more in height. The tubes are immersed in an atmosphere of steam, and in these tubes the rectification is accomplished, the greater part of all the congeners of fermentation except ethyl alcohol being separated by passing through these tubes.

The fusel oils are collected and utilized in commerce for making amylacetate, etc. The ethyl alcohol coming from the rectifying part of the still enters the second part, called the analyzer, which is a common chambered still in which the ethyl alcohol is condensed to about 94 per cent, by volume, pure alcohol. There is, of course, an incidental rectification due to this concentration, but the products of this rectification are not collected. The resulting product is an alcohol (ethyl) of high strength and purity. It is not a perfectly pure alcohol, but one of approximate purity, having left in it only a small part of those congeners of fermentation which give bouquet and flavor to pure whisky.

This product is also stored in wood, as was described in the case of malt whisky. It is the grain or silent spirit which is so abundantly used for mixing with malt whisky to produce the "Scotch whisky" usually met with in commerce. In respect of price the grain spirit, as described above, is much cheaper per proof gallon when first made than malt whisky of the same alcoholic strength. For instance, a proof gallon (English) of grain spirit is worth, when made, say, 30 cents. A gallon of malt whisky of the same strength is worth 50 cents. The commercial advantage of using large quantities of grain spirit in the preparation of the whiskies of commerce is at once apparent. The manufacture of grain spirit is conducted under the same excise supervision and regulations as are applied to malt whisky. It follows that it is possible for the excise officials to follow each package of such spirit from the time it is made until it is delivered for domestic consumption or for export.

A mixture of yellow and white maize is used in the manufacture of this grain spirit. Inspection of the maize used showed it to be of fair average quality. The amount of malt employed, aside from the quantity necessary to convert the starch, is optional with the manufacturer. Since the distillate is rectified, there is no advantage, in so far as the subsequent use of the product for mixing is concerned, in using a larger quantity of malt than is required to furnish the requisite vigor of diastatic action. Samples of malt whisky and of grain spirit were secured under careful supervision in many distilleries, sealed, and forwarded to the Bureau of Chemistry for analysis.

IRISH WHISKY.

The number of distilleries in Ireland is small compared to Scotland, but they are generally of a very much greater capacity. Distilleries in the north of Ireland, and at Belfast and Dublin, were inspected. Irish whisky is quite different in composition from

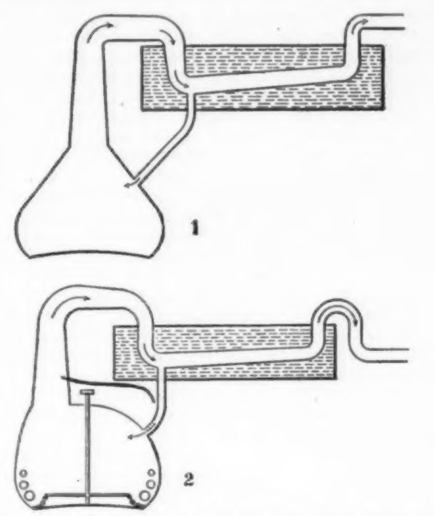


FIG. 4.—TWO TYPES OF IRISH POT STILLS.

Scotch. In Ireland very little pure malt whisky is made. On the other hand, it may be said that Irish whisky does not resemble that of American origin to any greater extent than it does Scotch. Only one distillery of those visited in Ireland uses malt alone. The others use malt, together with unmalted barley and a small quantity of other cereals, such as rye, wheat, and oats. Indian corn, apparently, is not used at all, or at least only to a limited extent. The malt which is used is not dried over peat, and hence the Irish whisky does not have that smoky taste so characteristic of the Scotch product.

Usually, when unmalted grain is used, malt makes up about one-half of the whole mash. The other half consists largely of unmalted barley, very small quantities of rye or oats, or both, being used. The mashing, the cooling of the wort, and the fermentation are conducted as in Scotland. The distilleries are of great capacity, and the vats and stills correspondingly large in size. For this reason the pot stills, although usually heated over an open fire, are reinforced by steam coils. The method of distillation is the same as in Scotland, but the whisky is warehoused at a much higher proof, viz., about 67 per cent by volume. Practically all the beer stills are supplied with a horizontal attachment to the neck before the pipe enters the worm, where a partial condensation takes place, this product being

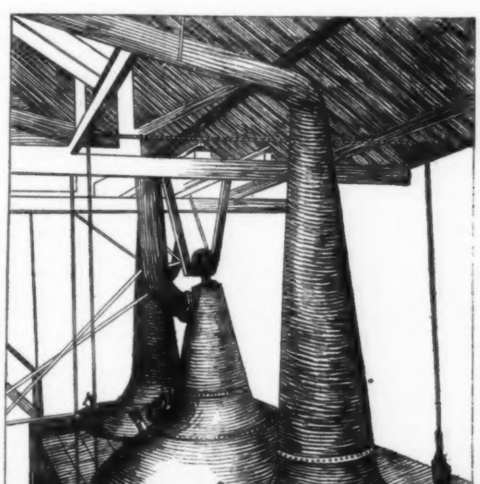


FIG. 5.—IRISH POT STILLS, SHOWING ATTACHMENTS.

returned directly to the still, thus producing low wines of greater alcoholic strength. The finished product is thus secured with a higher per cent of alcohol.

The accompanying illustration (Fig. 4) shows the form of the stills used at two of the Dublin distilleries. There are six huge pot stills of the type shown as No. 1, Fig. 4, holding from 19,000 to 25,000 gallons each, under which 50 tons of coal a day are burned. In addition to the open fire each still, except the spirit still, has an auxiliary steam coil. The stills are in batteries of four, two for producing low wines, one for special treatment of the feints, and one low wine still for the purpose of making the spirits of the proper strength. The extra concentrating still for the feints is required because Irish whisky is distilled at a very high proof, namely, 49 over proof British. It is bonded at 25 over proof British, much stronger than the Scotch whisky, which is usually bonded at 11 over proof. It will be noticed that the stills have rather high necks, curving down into a long horizontal portion lying in a trough surrounded with cold water. The condensation is returned to the still from this horizontal condenser in a continuous stream. It is evident that the triple distillation of the feints and the cooler attached to the horizontal portion of the neck secure the return of a considerable portion of the heavy alcohols to the still and their final removal in the burnt ale.

At another Dublin distillery presenting the same general type of still the rouser or stirrer enters directly at the top of the still, the neck being placed at one side to make this arrangement possible (Fig. 4, No. 2). A general view of some Irish pot stills, showing attachments, is given in Fig. 5.

There are grain spirit stills also in Ireland, and one of these in Dublin was visited. It is claimed in this distillery that the production of grain spirit is incidental to the manufacture of yeast, which is the principal product, the grain spirit being a by-product. Immense quantities of yeast are made at this distillery and supplied to bakers all over the United Kingdom. Indian corn, converted with malt, is the grain chiefly used. It is said to give a better yeast than can be produced from any other cereal.

Mixing and compounding warehouses are also found in Ireland, but it is claimed that a great deal of Irish whisky, guaranteed to be genuine, is bottled strictly for the export trade to the United States.

It is only fair to say, in respect of these so-called blended goods, especially "Scotch whisky," so called, that the compounders expressed an entire willingness to label such goods "blended" or "compounded" should our regulations require such a designation. It is stated that the genuine Scotch whisky, while it can be drunk with impunity in the Highlands, is not suitable for consumption in London and other parts of the empire without being softened by admixture with a spirit of low flavor. The compounders would not like, however, to put upon the label the degree of dilution practised, nor to name the diluting spirit. Compounds are made of from 20 to 80 per cent of grain spirit, according to the price the customer is willing to pay. Every vat compounded is accurately described in the books of the excise officers, so that an official certificate could be given were it in harmony with the regulations. Similar books are kept also by the compounder. Both sets of books were freely shown.

WAREHOUSING.

As soon as the spirits are made, whether from malt or from Indian corn, they are gaged and placed in casks under the supervision of the excise officers. The term "warehouse" is described as follows in the Regulations of Boards of Customs and Inland Revenue, page 12, paragraph 13: "A secure place, approved by the board, for the general service of the public, for the deposit of dutiable goods on which the duty has not been paid." The doors of a warehouse must open into a street or public way. It must be apart from a distillery or rectifying house. It must not have connection of any kind with the premises of a dealer in spirits.

Spirits and wines may be racked, vatted, or blended as often as required by the proprietor on his written request made in proper form. These operations, however, may only be performed in a special compartment of a warehouse used solely for that purpose. (Paragraph 301, Excise Regulations.) The proprietor may mix wines or foreign spirits together and may elect the name to describe the process, either vatting or blending, and may make the resulting product accordingly, but whenever any other article, allowed by the regulations, is added, or if any part of the spirits used have been previously vatted or blended, the operation shall be called "vatting." (Paragraph 303.) It is evident from this regulation that the excise desires to limit the word "blending" to a mixture of spirits or fermented beverages of the same kind. This is an important distinction and a just one. An effort should be made to restrict the use of the word "blend" in the manner indicated.

In the malt distilleries visited there was no vatting or blending practised, and no mixing with grain or other spirits. The pure malt whisky is sent to the large rectifying warehouses in Edinburgh, Glasgow, and London for these operations.

For home consumption, only the following kinds of spirits may be vatted or blended:

(*a*) Wines of the same sort, country, and rate of duty.

(*b*) Foreign spirits of the same denomination, irrespective of the country of importation.

(*c*) British spirits of the same sort.

By special permission of the board the following kinds of beverages may also be vatted or blended for home consumption:

(*a*) Wines which have been fortified with more than 10 per cent of spirit.

(*b*) Wines which have been fortified to a strength beyond 40 deg.

(*c*) Wines which have been unintentionally fortified beyond 40 deg. (Paragraphs 307, 310.)

One of the most important points connected with the warehouse treatment of wines and spirits is that manipulations are allowed for export which are not permitted for home consumption. For instance, it is

provided that "wines or foreign spirits not sweetened or mixed, of different sorts, may be mixed together for exportation only." (Paragraph 321.) British plain spirits may also be mixed for exportation with foreign spirits not sweetened or mixed. On one head of the cask in such cases the word "mixed" must be marked. (Paragraphs 323-334.) When British compounds exceeding 11 over proof are mixed with British compounds not exceeding 11 over proof it must be written in the dispatch "for exportation only." (Paragraph 326.) Imitation rums—that is, any mixture not rum, but simulating in some way that substance—may be mixed with other foreign spirits and are described in the accounts as "foreign spirits of various sorts mixed in bond." (Paragraph 324.) This provision permits the concoction of almost any kind of mixture the merchant may desire to export.

Should "spirits of wine" (alcohol) on which the allowance has been paid on deposit be at any time mixed with plain British spirits, the allowance payable on the exportation of the latter is to be determined, but the spirits will be inadmissible for home consumption. (Paragraph 326.) Ordinary finings, such as Spanish earth, albumen, patent finings not sweetened, isinglass, milk, etc., may be added to wines not exceeding 42 deg. of alcoholic strength for home consumption as frequently as the proprietor may deem necessary. Sweet finings may, with the sanction of the board, be used in wines for home consumption in quantities not exceeding 1 per cent, but without limit for exportation. (Paragraph 331.) Coloring or sweetening matter may, with the board's sanction, be added to wines of different sorts mixed in warehouse for exportation. The casks are to be marked "mixed and sweetened wines" and entered on the books for exportation only. (Paragraph 332.)

We now come to some of the most important of the regulations for warehouses as affecting the different treatments of beverages intended for home consumption and for export. It is provided that coloring matter in a fluid state may be added to British spirits for home consumption in the proportion of 1 pint to each 80 gallons. When such coloring matter has been added a full statement concerning it must be entered in the books and all further removals or manipulations of spirits so colored must be accompanied by statements of the fact. (Paragraphs 334-335.) It is then possible for the excise officer to know through all vattings and blendings just what portions are artificially colored. The regulations thus guard the consumer's rights respecting the use of artificial color, and no other ingredients, except all forms of British-made spirits and this coloring matter, may enter into any mixture intended for home consumption. It is very different, however, when the goods are to be sent to other countries. Section 337 makes legal in the warehouse any admixture whatever that the merchant, mixer, or compounder may see fit to use in preparing spirits for foreign markets. This section is so important that it is quoted in full:

"337. British spirits for exportation or ships' stores may have any sweetening or coloring matter or any other ingredient added to them in warehouse by a distiller or rectifier. The spirits must, except as provided for in paragraph 336, be removed into a separate room or compartment having no communication with the other part of the warehouse except by a door under Crown lock."

An important item in the regulation is that this mixing must be done in a separate compartment of the warehouse, locked off from the part where goods for home consumption are mixed.

The kinds of spirits which may be used in fortifying wine in warehouses are as follows: Foreign spirits unsweetened; British plain spirits; spirits of wine. (Paragraph 358.) Foreign spirits may have any origin whatever—that is, they may be made from grain, beet roots or molasses, potatoes, etc.

"British plain spirit" is the common name given to all spirits distilled in Great Britain or Ireland. These spirits are chiefly made from malt, as Scotch whisky; from a mixture of malt and other grain, as Irish whisky, or from Indian corn, as grain spirit or silent spirit. Spirit of wine is commercially pure, rectified alcohol.

The British regulations, as will be seen from the above abstracts, conserve carefully certain rights of the British consumer, but legalize any kind of manipulation whatever when the goods are to be sent on board ships or to foreign countries.

BOTTLING IN WAREHOUSES.

Any kind of mixed or compounded spirits may be bottled in bond for ships' stores or for exportation, and any spirits which are not inadmissible may be bottled for home consumption. (Paragraph 378.)

Spirits intended to be bottled must be removed in the presence of an officer from the warehouse into a bottling warehouse, where they may be blended and the strength reduced with water to any degree that may be required. (Paragraph 379.) For home consumption the bottles must be imperial or reputed quarts or pints. For exportation bottles of any size or quality may be used. (Paragraphs 382, 383.) In case of home consumption the officer is to see that each package is marked on the outside "Spirits," "Whisky," or "Compound spirits," as the case may be (paragraph 388), but this is not required in case of exportation.

In regard to labels on bottles the British regulations give the merchant a free hand. He may use any form of label or statement he likes, except that he must not ascribe any responsibility to the inland revenue. Paragraph 389 reads:

"Officers are not to interfere with labels used on bottles or cases filled or made up in bond beyond seeing that no label or inscription contains such expressions as 'Bottled in bond,' 'Bottled in customs (or excise) warehouse,' or any other indication implying official countenance or guaranty of the correctness of the statements made."

OFFICIAL DEFINITIONS.

In order that the terms used in this *résumé* may be properly understood the following official definitions are given (paragraphs 18-25, 27-32, 42):

Spirits.—All spirits whether British or foreign.

Foreign spirits.—Spirits liable to a duty of customs.

British spirits.—Spirits liable to a duty of excise.

Plain spirits.—Such as are in their original state, having had no artificial flavor communicated to them.

Spirits of wine.—Spirits of 43 per cent over proof and upward rectified from duty-paid spirits by a licensed rectifier.

Compounded spirits.—Spirits prepared by a rectifier or compounder by redistilling duty-paid spirits with flavoring ingredients or adding to them any flavoring materials.

Liqueurs and tinctures, etc.—Compounded spirits the ingredients of which interfere with the correct action of the hydrometer. British liqueurs may be deemed to include all sweetened or otherwise obscured British compounds, including essences and perfumed spirits, of which the true strength cannot be ascertained without distillation.

Sweetened spirits.—The term as applied to spirits imported in bottles means a spirit to which any matter has been added after distillation which imparts to it the quality of sweetness and procures obscuration to the amount of over 0.6 per cent.

Obscuration.—The difference, caused by matters in solution, between the true strength of spirits and that indicated by the hydrometer.

Vatting.—Putting together wines or spirits into a vat or large vessel to obtain uniformity.

Blending.—Putting together wines or spirits of similar sorts.

Mixing.—Putting together wines or spirits of different sorts.

Filling.—The making good of natural waste in casks of wines or spirits by the addition of liquor of the same or similar kind.

In the light of the above definitions it does not appear that the mixing of malt whisky, such as that described at first, with grain spirit can be justly called "blending." The two spirits are entirely of a different class, and therefore the word "blend" does not correctly designate the resulting product. The word "vatting" might be used in harmony with the definitions given, but that word would not convey any definite meaning further than the idea of mixing different liquors in a vat. The word "compounding" perhaps would, on the whole, be the best designation of the process and "compound" of the product.

SOME FACTS ABOUT VARNISH.

THE word "varnish" is understood to be derived from the Latin *vitrinere*, meaning to glaze or produce a glass-like surface. Of the great variety of gums used in the making of varnish, shellac is the most useful for spirit varnishes. Although the annual consumption of gum shellac in this country is now about 5,000 tons, there are points about it not generally known or understood. It is not a resin in the strict sense of the word—i. e., it is not the simple juice of a tree—but results from the action of certain insects on the juice, and contains several very peculiar resins.

Next to shellac sandarac ranks as the most valuable gum for spirit varnishes. As for the regular gums although the list in books is a long one, practically all that varnish makers are interested in may be counted on the fingers of the hands, and this can be further reduced to four, viz., Zanzibar, Kauri, Manila, and Damar. The impression prevails that great quantities of these gums are shipped to the American market, but such is not the case. The imports for the year 1905 were not much in excess of 13,000 tons, and of this about 50 per cent was Kauri.

Zanzibar stands at the head, being the hardest of all gums, except amber, which need not be considered. It derives its name, as may be inferred, from the port of shipment, as indeed most other gums do, excepting, perhaps, Manila. We speak of all these hard gums as "fossils," because they are found in a fossilized condition in the ground, sometimes hundreds of feet below the surface. Zanzibar is dug out of the sands of the African desert, and the curious indentations which give this gum the appearance of goose skin are simply sand impressions. The Zanzibar gum is scarce and very expensive.

Next in point of costliness, but far in advance in point of usefulness to the varnish maker, are the New Zealand copals, commonly called "Kauri" gums. They range in color from a creamy white to a dark brown, and are so graded. Much of this gum is not available for use, and the assorting requires skill and care. The lower grades contain pitch and swamp gum, the former being taken from the forks of trees 100 feet or more above the ground. It is a soft, spongy mass, and it is extremely difficult to incorporate with the oils. Ninety per cent of what is imported, however, may be classed as good hard gum, differing only in size, color, and clearness.

Manila gum is a soft copal exported from the Dutch East Indies. It is in more or less demand, but varnish makers have no great use for it. However, a small quantity sometimes helps to give elasticity to harder gums, and occasionally it is used in spirit goods. For general use its greatest drawback is the difficulty of eliminating the pyroligneous acid, of which it carries quite a large per cent. There are many other varieties of gums in the same class as Manila, but they are not used to any considerable extent; perhaps 1,000 tons would cover the annual importation.

The blacks are a small line mostly used in baking or air drying japans and varnishes. Originally our supplies of asphaltum, which is supposed to be the product of decomposed animal and vegetable matter, came from the shores of the Dead Sea, and "Egyptian" continues to be one of the best grades. We now get a considerable quantity from both Trinidad and Barbados, and Cuba sends us an asphaltum that is densely black. In this country Colorado and Utah mine very heavily. There are other blacks besides asphaltum, but as a rule they do not interest the varnish maker—such as coal tar pitch, resin-pitch, candle-pitch, etc. There is more or less interest attached to all these crude materials which enter into the composition of varnish, but space will not permit of my dwelling on them at length. One other, however, I will mention—China wood oil. This is a much more expensive oil than linseed, and very hard to manipulate to get proper results, but is none the less a most valuable article for those varnish makers who have mastered its secrets. When worked in the same way as linseed oil it makes a harder, more elastic and more durable varnish.

As for the different grades of varnishes, the numerous catalogues which are issued show what a large variety of varnishes there are for sales purposes; but the classification may be considerably modified. Originally there were but two classes on the market—carriage varnishes and furniture varnishes. The introduction later of so many beautiful woods in building operations made an architectural line imperatively necessary. Outside of the above the manufacturers' lines and specialties make an almost endless list; yet they are all modifications of a general line to suit certain conditions, and for the most part are obtained by blending.

All the better grades of varnish, no matter what the line, are made of selected gums and of specially prepared oils, with pure turpentine as a thinner. The cheaper grades will naturally carry poorer gum, and be thinned with either naphtha or part naphtha and part turpentine.

Speaking of naphtha and turpentine thinners, it may be interesting to know what the essential difference is. The turpentine varnish undoubtedly works easily, and it dries from the bottom up. With naphtha these features are reversed. Sometimes it forms a skin over the top, keeping out the oxygen, and so retarding the drying. Another serious fault with naphtha goods is that they do not flow as turps does. Both, however, are used merely as distributers, for neither stays where it is placed, but evaporates in due course. Most of the difference between the two liquids lies in the fact that turpentine carries a percentage of oils and naphtha does not. It is easier and better to thin with turps because it can be added at a higher temperature —350 deg. to 360 deg. F.—and at this temperature the combination of gum and oil is more perfect.

There are many terms in the technology of varnish which convey no definite meaning to the outsider; yet they are full of suggestions as to the possibility for use of said varnish. For instance, the varnish maker speaks of "slack melt." By this is meant that the gum is melted in a covered kettle to a semi-liquid condition before the oil and thinners are added. The result is a large yield, good color, hard working, and a false body. The batch takes a large quantity of thinners, which in itself causes a loss of gloss. The object is simply good color, or large yield, or both. There is more or less moisture left in this varnish and if mixed with pigment it would be apt to liver. If it did not do that it would not mix well. So for this purpose the using of a "slack melt" is to be avoided.

An "open melt" is when the cover is left off the kettle, the object being to throw off as much moisture and copal oil (the oil that is in the gum) as possible. When this is not done the varnish is liable to "bloom," and the oil mentioned retards the drying.

For a "close melt" the cover is left on and a larger yield is produced, as most of the gum is retained in the kettle. This is used for the cheaper grades than the best. Good results are also obtained in a "close melt" by different manipulation. One way is to melt the gum to a liquid state before the oil is added. In doing this the color and yield are sacrificed to a certain extent, but finer results are produced as to gloss, drying, freedom of working and wearing qualities. In all gum melting too strong a fire is to be avoided or the gum will be burned.

Zanzibar and other fossil gums are difficult to handle. Usually the heat varies from 550 deg. to 640 deg. for the harder gums. Japans (outside of the grinding varieties, which are made with shellac and gums) and liquid dryers are usually made by boiling lead and manganese with linseed oil, combining as much metal as possible with the oil, and driving off the oxygen with long sustained heat.

It is a truism that good varnish depends more on the makers than on the material. This has frequently been proven, since with the same material one man has made a good varnish and another a very poor one. Thoroughly competent men for this work are scarce. It requires brains, nerve, judgment, and a perfect knowledge of materials—not merely the crude material, but of the finished product, and what it has to accomplish. He must be weather wise also, for under certain circumstances the weather is a most important factor to consider. For instance, the atmosphere indi-

cates possible mugginess, with little or no draft. He realizes at once that he must make up the strongest kind of a fire before he runs the kettle on, otherwise the contents will simmer, darken, and spoil. Or again, he may wish to make a varnish of another class, which requires a bright, clear day, with not too much wind. The successful varnish maker must be able to cope with all of these conditions. He must be a man of discernment, capable of perceiving possible danger or loss before the actual crisis arrives, and a man of resource, so that he can constantly meet, counteract and overcome any troubles which may arise to hinder the successful making of his varnish.—Gordon Montagu in the American Exporter.

INTERNAL COMMERCE DURING THE YEAR 1906.

INTERNAL commerce movements during 1906 exceeded those for any preceding year in the history of the country. This fact is apparent from compilations of the year's record just completed by the Bureau of Statistics of the Department of Commerce and Labor. While the movements during December and others of the later months of the year were less than those for the corresponding months of last year, due probably in a considerable degree to car shortage, the grand total for the year exceeds that of any prior year.

Receipts of live stock at interior primary markets during 1906, while they exceeded to a small extent similar activities in 1905, showed an appreciable decrease during the last few months of the year. During December receipts at Chicago, Kansas City, Omaha, St. Louis, St. Joseph, St. Paul, and Sioux City, amounted to 3,285,529 head, falling nearly 200,000 head below like arrivals in 1905, and more than 10,000 head below those for 1904. Compared with the December, 1905, movement, all of the markets specified reported a decrease with the exception of St. Paul, where a gain of approximately 20,000 head was made. For the full year live stock receipts at these markets aggregated 4,727,658 head, exceeding corresponding movements in 1905 by more than 150,000, and those in 1904, by nearly three millions. The gain shown in the aggregate movement, as compared with that of 1905, was caused by heavier receipts at Kansas City, Omaha, and St. Louis, losses having occurred at Chicago, St. Joseph, St. Paul, and Sioux City. Of the different animals received, cattle constituted 9,373,825 head; calves, 796,793; hogs, 19,223,693; sheep, 10,864,427; and horses and mules, 468,920. Gains were made in the arrivals of cattle, calves, and sheep, while losses occurred in those of hogs, horses, and mules.

Shipments of packing-house products from Chicago during December amounted to 218,525,254 pounds, falling below those of December, 1905, by over 20 million pounds, but exceeding those for the like month in 1904 by nearly 30 million pounds. Beef constituted 7,249,300 pounds of this total; canned meats, 5,989,725; cured meats, 54,595,194; dressed beef, 88,347,990; dressed hogs, 1,615,650; hides, 18,594,223; lard, 39,793,772; and pork, 2,339,400; and as compared with corresponding movements in 1905, all the articles specified showed a decrease with the exception of beef, hides, and pork. Canned meats appear to have been the heaviest loser by such comparison, the shrinkage having amounted to somewhat over 9 million pounds. During the full year aggregate shipments were 60,776,900 pounds of beef, 117,688,650 canned meats, 804,642,049 cured meats, 1,138,072,285 dressed beef, 13,170,300 dressed hogs, 175,170,520 hides, 421,914,539 lard, and 36,581,200 pork, a total of 2,768,016,443 pounds, being over 100 millions greater than that for 1905, and more than 300 millions in excess of 1904. The shipments of all products with the exception of canned meats and dressed hogs present gains if compared with those of either of the two immediately preceding years.

Grain receipts at fifteen interior primary markets during December totaled 75,576,714 bushels, compared with 86,894,965 bushels in December, 1905, and 77,835,544 in December, 1904. Wheat constituted 25,888,197 bushels of the movement; corn, 23,676,472; oats, 15,658,360; barley, 8,821,949; and rye, 1,531,736; all but wheat and rye showing losses as compared with corresponding arrivals in 1905. For the year grain receipts at these markets aggregated 798,521,585 bushels, exceeding those in 1905 by approximately 250,000 bushels, and those in 1904 by about 80 million bushels. The total movement was divided into 243,735,058 bushels of wheat; 242,722,716 corn; 233,300,239 oats; 69,469,290 barley; and 9,294,282 rye. Compared with the arrivals in 1905, losses occurred in the receipts of wheat, barley, and rye, but were more than offset by the gains made in the corn and oats movement.

Eastbound trunk-line movements of grain from Chicago and Chicago points during December totaled 9,604,000 bushels, falling below corresponding shipments in 1905 by over 2,600,000 bushels and below those of 1904 by more than 700,000 bushels. Shipments for the year, however, show an appreciable increase by a like comparison, having been 114,062,000 bushels in 1906, 112,220,000 in 1905, and 90,501,000 in 1904.

Receipts of grain at six Atlantic and Gulf ports during December amounted to 18,950,850 bushels, falling below corresponding arrivals in 1905 by nearly 13 million bushels, but exceeding those of December, 1904, by more than 3 million bushels. Boston received 3,214,923 bushels; New York, 7,300,628; Philadelphia, 3,022,883; Baltimore, 3,385,416, and New Orleans, 2,027,000, losses occurring at all ports specified as compared with like arrivals in 1905. During the entire year Boston received 26,496,320 bushels of grain; New York, 89,365,846; Philadelphia, 28,073,289; Baltimore, 39,600,786, and New Orleans, 31,310,757, a total of 214,846,998 bushels, compared with 200,186,727 in 1905, and 119,125,238 in 1904. Compared with the preceding year's movement, all ports show gains with the exception of New York where a loss of over 1½ million bushels occurred.

Shipments of anthracite coal from eastern producing regions during December amounted to 4,836,028 tons, nearly 450,000 tons below like movements in 1905 and over 225,000 less than those for 1904. For the entire year such shipments from this district aggregated 55,647,296 tons, in contrast with 61,410,201 in 1905 and 57,498,642 in 1904. The losses indicated for 1906 were principally due to the suspension of mining during April and part of May.

The estimated production of coke at Connellsville during 1906 amounted to 14,436,928 tons and exceeded like production in 1905 by over a million tons and that in 1904 by approximately 4½ million tons.

The volume of freight traffic on the Great Lakes during 1906 established a new high record for those great bodies of water, notwithstanding that the preceding year was also one of maximum tonnage. Toward the end of 1906, inadequate rail facilities assisted materially in increasing the volume of water traffic, this being particularly true with regard to grain movements. In the aggregate, the gains made in freight tonnage were enormous.

During December total freight shipments from all ports on the Great Lakes, exclusive of exports to Canada, amounted to 2,603,096 net tons, exceeding similar movements in 1905 by over 450,000 tons, and those in 1904 by nearly a million tons. For the entire year shipments of a like character aggregated 75,610,690 net tons, in contrast with 67,345,620 shipped during 1905, and 51,370,855 in 1904. Of the different articles transported, flour amounted to 1,334,979 tons; grain and flaxseed to 4,211,197 tons; coal to 17,575,917 tons; ore and minerals to 43,030,419 tons; logs and lumber to 3,993,165 tons, and unclassified freight to 5,465,013 tons. With the exception of logs, all commodities showed heavy gains over the shipments of the preceding year; the gain in iron ore amounted to nearly 5 million tons.

During December vessel clearances on the Great Lakes numbered 2,954 of 3,484,561 net tons, in contrast with 3,290 of 3,178,405 tons in December, 1905, and 2,654 of 3,115,159 tons in December, 1904. During the entire year vessel clearances from all ports on the Great Lakes aggregated 81,271 of 94,893,961 tons, against 79,908 of 87,978,397 tons cleared in 1905, and 68,967 of 67,773,295 tons in 1904. Of the 1906 movement, 21,004 vessels of 28,470,554 tons cleared light or without cargo, and 60,267 of 66,423,407 tons carried more or less freight.

The total movement of domestic freight through Detroit River during December amounted to 2,046,636 tons, of which 810,167 tons moved in a northerly and 1,236,469 in a southerly direction. During the year to December 31, aggregate movements through this waterway amounted to 60,578,155 tons, divided into a northbound movement of 16,448,812 tons, and a southbound movement of 44,129,343 tons. Coal constituted the bulk of the freight shipped from the lower to the upper lakes, amounting during the year to 14,522,031 tons, while unclassified or package freight totaled 1,303,042 tons. In the opposite direction grain, flaxseed, flour, and iron ore were the principal commodities shipped, and were divided in the following manner: Grain, 119,480,821 bushels; flaxseed, 17,758,376 bushels; flour, 1,237,652 tons, and iron ore, 32,208,009 tons. Vessel movements through this river during the year numbered 24,062 of 47,076,781 net tons, those passing in a northerly direction numbering 11,618 of 22,681,761 tons, and those in a southerly 12,444 of 24,395,020 tons.

The commerce through the canals at Sault Ste. Marie, Mich., and Ontario, Canada, both for December and the season, presents another striking illustration of the unusual traffic activities of the Great Lakes during 1906. During the month freight movements in both directions through these waterways amounted to 1,558,246 tons, exceeding corresponding movements in 1905 by nearly 300,000 tons, and those in 1904 by almost 600,000. For the entire season like movements aggregated 51,751,080 tons, an increase of approximately 7½ million tons over the preceding season, and of nearly 20 millions over that of 1904. The United States canal cared for 45,180,292 tons, and the canal in Canadian territory for 6,570,788, while of the entire movement, 41,584,905 tons moved in an easterly and 10,166,175 in a westerly direction. The principal items in the former movement were 138,607,764 bushels of grain, 6,484,754 barrels of flour, and 35,357,042 net tons of iron ore, while of the latter, 8,739,630 net tons of coal and 984,265 net tons of general merchandise composed the bulk of the tonnage. As compared with like shipments in 1905, grain gained over 30 million bushels, flour more than 700,000 barrels, iron ore approximately 4 million tons, and coal over 2 million tons.

IMITATION SILVER.

A GOOD imitation of sterling silver may be made of the following mixture:

Copper	10 oz. or 50 p.c.	
Silver	5 oz. or 25 p.c.	
Nickel	5 oz. or 25 p.c.	

In order to impart good rolling qualities, it is necessary to add a small quantity of manganese to the mixture. About 0.10 per cent is all that is needed. This should be added in the form of 30 per cent manganese-copper. To the above mixture, therefore, add 1 pennyweight of 30 per cent manganese-copper. The mixture then becomes:

Copper	10 oz. (Troy)
Silver	5 oz. (Troy)
Nickel	5 oz. (Troy)
Cupro-manganese	1 dwt.

The mixture is put into the crucible together and melted under borax. It can be rolled into sheet like sterling silver. The silver imparts whiteness to it, while the nickel gives it non-corrosive qualities.—Brass World.

SCIENCE NOTES.

The human pulse has rather a wide range even in perfectly healthy persons. The female pulse always beats faster than the male, and from birth to death the pulse speed steadily decreases. It has been asserted by many eminent physicians that there is no doubt that by the beat of the pulse alone the sex and age of a person could be told. Babies at birth have a pulse beat of 160 times a minute in the case of girls and 150 a minute in the case of boys. At the age of four or five the pulse beats will have fallen respectively to 110 and 100. Maidens' and youths' pulses average 95 and 90. Mature women and men average 80 and 75. Elderly women and men have an average pulse beat of 60 and 50. An old woman's pulse rarely, if ever, sinks below 50, but among old men a beat under 50 is very common. There are, however, great variations consistent with health. Napoleon's pulse is said to have been only 44 beats to the minute. There is a case on record where the pulse of a healthy man at the age of 87 seldom beat over 30 to the minute during the last two years of his life, and sometimes not more than 27.

Warned by the great damage caused by the recent fire at the Milan Exposition, in which valuable paintings, tapestries, and other works of art were destroyed by fire, the deputy commissioner-general of the International Maritime Exposition which is to be held at Bordeaux from May to October next, in commemoration of the hundredth anniversary of Fulton's successful application of steam to navigation, has devoted much of his time to the study of the different methods of rendering wood, paper, silk, cotton, and woolen stuffs non-inflammable. Of all the formulæ submitted, he decided to experiment with the following: Sulphate of ammonia, 135 grammes; borate of soda, 15 grammes; boric acid, 5 grammes, and water, 1,000 grammes. The exhibition consisted of treating pine shavings, wood, paper, and cotton fiber with this preparation and, after a thorough drying, applying the fire test. A huge pile of shavings, pine kindlings, and wood was set on fire, and in the blaze were thrown shavings and sticks of wood impregnated with this "Ignifuge." When the fire had exhausted itself, the impregnated shavings and wood were found to be simply blackened and charred; they gave out no flame. Paper and cotton fiber treated with the same solution, when exposed to the flames, consumed very slowly without a blaze. So successful and conclusive seemed the demonstration, that orders were immediately given that all wood used in the construction of the exposition buildings and all cotton, canvas, and linen stuffs, carpets, and rugs employed in the furnishing thereof should be treated with this "Ignifuge." The method of applying the preparation to heavy timbers, carpets, etc., is by the use of a huge sprayer strapped to the backs of workmen. The sprayer in construction is similar to the fire extinguisher.

The old ideas of the nature of matter or of atoms have all been abandoned and we have come to the conclusion that matter is not inert but is loaded with energy, that indeed the ether is saturated with it, though it is available to us only through the agency of matter, which acts as a transformer and a distributor of it. Yet we need to know much more of it. There is more to be learned about chemistry in its relation to physics than any seems to have considered hitherto. It is the form of energy which is present in atoms. Thus when hydrogen and oxygen unite they give out a surprising amount of energy in the form of heat. A single pound of this combination, taken at ordinary temperature, will give out an amount of heat equal to seven million foot pounds of work, or sufficient to raise a ton one-half mile high. We know that heat is a vibratory kind of atomic and molecular motion and the rate of this vibratory motion is the measure of the temperature. The question is as to the antecedent of the heat which thus appears. In what form does energy exist in atoms? Up to this time we have been able to trace energy through its various forms until we come to atoms; there it has eluded us. We say "chemical energy," but we have no idea how it differs from heat or from gravitative energy. It is a mystery. What form of motion or stress can be thus embodied? In some way it is related to the ether. It seems as if in some unique manner atoms drew from the ether as from a common reservoir, each particular atom capable of holding so much of that kind and no more, like pint cups and quart cups, and this at once transformed into heat at the instant of combination. When combinations of atoms such as water are decomposed, they again absorb the energy spent to separate them, and an atom therefore possesses more available energy than any combination of atoms. It seems as if atoms acted as transformers of ether energy into the ordinary and familiar forms, such as heat and electricity, and *vice versa*, transforming the latter into ether energy. When we learn this secret we may likely enough be able to artificially extract from the *ether* as much energy as we need for any purpose, for as has been said, it is inexhaustible, and every cubic inch of space has enough for all the needs of a man for many days. This seems fairly probable,

and when the source of atomic energy is discovered, it will rank with the greatest scientific achievements of all time. We shall know more of the ether, of the structure of matter, of the antecedents of most of the energy we are familiar with, as this phenomenon underlies most if not all of the phenomena in all the sciences.

ENGINEERING NOTES.

According to the Iron Trade Review, the United States has entered upon a period of what promises to be a time of the most extensive construction of blast furnaces and open-hearth steel plants in its history. The only year whose prosperity is comparable with that of 1906 is 1902, and while the actual number of plants being built is not so large as it was in the midsummer of 1902, the new construction authorized and certain to be carried out, unless there should be a totally unexpected slump in business, exceeds that of 1902, the increase being largest in furnaces making Bessemer and basic pig iron. There are now under construction in the United States twenty-one stacks, with a total annual capacity of 2,310,000 tons. Seven furnaces have been recently completed, with a capacity of 968,000 tons. The building of twenty-seven new furnaces, having an annual capacity of 2,965,000 tons, has been authorized. There are three old furnaces in Pennsylvania, and one in Michigan, long idle, with a capacity of 315,000 tons, which are soon to be blown in. This makes a grand total capacity of 6,558,000 tons for furnaces completed, under construction and authorized, the number being fifty-nine. As no account has been taken in these figures of the rebuilding of a number of furnaces, especially in the South, involving a large increase of capacity, it is a safe estimate to say that the new furnace capacity to be completed at no far distant day, is nearly 7,000,000 tons per year. There are now under construction forty-seven open-hearth furnaces, with an annual capacity of 1,016,500 tons, and twenty-one furnaces with an annual capacity of 530,000 tons have recently been completed. There are thirty open-hearth plants with an annual capacity of 1,194,000 tons authorized, making the total new open-hearth capacity 2,740,000 tons for ninety-eight furnaces, against 3,100,000 tons in 1902 for 118 furnaces. This does not include the open-hearth furnaces building for steel foundries, which are more numerous than they were in 1902. In 1902 no Bessemer construction was reported. The most important plant completed this year is that at Youngstown, having two 10-ton converters, with an annual capacity of 360,000 tons. Adding this tonnage to the open-hearth we have a grand total of 3,100,000 tons of steel-making capacity.

The steam turbine has now reached such a stage of development that inventions connected with it no longer deal with matters of theory, or designs intended to get more and more work out of a given weight of steam. Ninety per cent of the patents recently taken out in Great Britain, France, Germany, or the United States, are for improvements in details of construction, such as stuffing-boxes, thrust bearings, and, above all, speed regulators. It is well known that as with the water turbine so with the steam turbine, throttling the whole supply tells against efficiency. The right line for adoption where the design admits is the cutting out of one or more nozzles, just as in a water turbine the water is prevented from entering certain guide vane ports; the efficiency of the remaining deliveries is but little reduced. Many of the inventions made with this object in view are very ingenious. About seventy steam vessels have now been fitted with steam turbines instead of reciprocating engines. So far as can be gathered they have been successful; but complete statistical information is lacking. The question of vibration has not been settled; no doubt that due to the engine has been almost eliminated, that proper to the propellers has not. There still exists a doubt as to the superiority of the marine turbine over the reciprocating engine, and the satisfactory performance of such machinery as that of the London and South-Western Railway steamer "Princess Ena," recently described in our columns, will tend to strengthen the doubt. It would appear that we have adhered too long to a heavy slow-running type of engine, while better results could have been got with much lighter and smaller machinery. If engineers choose to take advantage of the better materials and better workmanship now available, there is no reason why 200 pounds pressure and 150 revolutions per minute should not take the place of the normal 160 pounds steam and 75 revolutions. The great success of the "Dreadnought" has apparently secured the adoption of the steam turbine in the navy. The new yacht being built for King Edward will have turbines. During the year the Parsons Marine Steam Turbine Company, Wallsend-on-Tyne, have supplied machinery to H.M.S. "Dreadnought," "Gadfly, and two torpedo destroyers, aggregating in all 43,000 horse-power. The Parsons Company has recently developed to some extent a new field for the steam turbine. It is now being employed for driving fans for blowing steel furnaces and other work, the pressure of the air being in some cases as great as 15 pounds on the square inch; but so far the quantities have been small, say 20,000 cubic feet of air per minute. The steam turbine has been suggested as an engine for driving mine ventilator fans, but there are as yet serious objections to its use for this purpose. The Guibal fan, for instance, runs much too slowly to be coupled direct to a turbine; ample supplies of condensing water are not always available, and so far no one has had direct experience with a turbine which will run successfully night and day for twelve months—a duty often performed by reciprocating engines.

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